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What Will China Stand on in the 21st Century

963A0031A Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENCE OF SCIENCE AND MANAGEMENT OF S&T] in Chinese 20 Dec 95 Vol 16 No 12, pp 4-9, 53

[Article by Tang Heming [0781 6320 7686] of the Bureau of Village Business, Shunqing District, Nanchong, Sichuan: "What Will China Stand on in the 21st Century — Rational Thoughts on Primary Productive Force"]

[FBIS Translated Text] It is the end of the 20th century and we will be entering the 21st century. No one doubts and no one denies that S&T plays a pivotal role in economic growth everywhere in the world. It is becoming ever more important in production output. Hence, it is known as the number one productive force. Since reform began in China, a great deal of progress has been made in S&T, particularly in applied technology. It is a critical factor in our economic growth. At the same time, no one can deny that there are still a number of S&T related issues, such as system, investment, benefit and economic relevance, requiring our immediate attention. Only after these issues are resolved can S&T then bring prosperity to China in the 21st century.

1. Sixteen years of controversy, S&T contributes to China's economic achievement to date.

In 1978, Deng Xiaoping was the first to point out S&T is the driving force behind productivity. Along with more in-depth reform, the economy grows at a rapid pace. More and more people started to recognize the importance of S&T to our economy. Hence, a S&T development system unique to China began to take shape.

Since the mid 1980's, China launched a series of S&T projects that were geared toward economic growth, including the national key S&T projects, key industrial experimental projects, Spark Plan projects, key S&T accomplishment promotion projects and construction of national engineering (technology) research centers. Such projects have pushed the conversion of S&T results to practical applications.

In order to remain competitive, China has a policy to set priorities in S&T. In 1986, China released an outline for its high tech R&D plan whose objective was to track the latest trends in S&T development around the world (also known as the "863" Program). Fifteen subjects in 7 fields, including biotechnology, information, automation, energy and novel materials, were selected as key high tech development areas. According to recent statistics, in the 5 fields organized by the State Science and Technology Commission, close to 700 accomplishments have been obtained to date. About 400 of them are at world levels of the mid or late 1980's. Some results are already at the cutting edge. For example, in biotechnology, China is ahead of western nations in genetic engineering for crops. In automation, an experimental project on computer controlled manufacturing received an international award — the "college pioneer award." This signifies that China is at the cutting edge in this field. Eight years after implementing the "863 Program," China had a well organized high tech research team. It includes a number of outstanding young people. In addition, 15 key research centers were built and a network of points to conduct experiments were established.

In the 1980's, a total of 15,000 S&T accomplishments were achieved; 12,000 of them were applied to various aspects of the economy, resulting in a direct economic benefit of 40 billion yuan. For instance, new technology in survey of resources significantly improved our current ability to explore ores. In steel production, techniques such as continuous casting and using rotating furnace with oxygen blowing have been widely adopted to save a large amount of energy. In transportation, engine power was increased substantially by retiring steam locomotives. In CAD of VLSI, close to 500 application-specific ICs have been developed for different industries such as electric power, chemical engineering, textile and light industry. In consumer products, a large number of new techniques and products were developed.

The Spark Plan was primarily designed to stimulate China's rural economy. In the past 10 years, 43 national class Spark Plan technology intensive zones have been established and a total of 51,000 items were completed. Furthermore, a total of 20.7 million rural technical management personnel were trained. The effect is very apparent. According to statistics, S&T progress accounts for 42 percent of the increase in agricultural output.

China also has accomplished a great deal in technology development and innovation. During the 6th and 7th 5-Year Plans, we implemented over 450,000 projects and invested 550 billion yuan. This is 31 times the investment made over the first 28 years of PRC. During the 8th 5-Year Plan, approximately 4,000 major S&T accomplishments were converted to productivity every year. Technological development and improvement increases the vitality of a large number of medium and large size companies in China.

While S&T is feeding economic growth, commercialization of technology is also picking up pace in China. According to statistics compiled by the office of the Torch Plan at the State Science and Technology Commission, a total of 52 national high tech industrial zones and a number of provincial high tech development parks

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have been established in 27 provinces and autonomous regions since 1985. In 1994, the total revenue of all national high tech development zones was more than 100 billion yuan. There is a boom in the number of S&T companies. Some of them are the top performers of modern Chinese enterprise. S&T research institutes are spinning off various businesses to convert high tech accomplishments to products. Shanghai Institute of Metallurgy, on the basis of its technical strength, has been focusing on highly profitable development projects. Three of its high tech companies have a combined revenue of 20 million yuan and earnings of 4 million yuan. They also generated $500,000 of hard currency.

2. Capital investment is the bottleneck which makes S&T development difficult in the 21st century.

Although a great deal of progress has been made in S&T, China, as a whole, is still lagging behind other developed nations in terms of technical strength. According to statistics, the yearly average cost to support a researcher is $150,000 in the U.S. and $100,000 in Japan. In China, it is 31,300 yuan for each technical staff in research and development. As a developing country, China's investment in S&T is indeed low. However, opinions on the level of investment in S&T vary, which affects the policy-making process.

"Total S&T investment" is a term used widely in S&T. It divides our S&T activities into three categories: R&D, conversion of accomplishments to applications and technical service. The sum of expenses for these three categories is the total S&T investment. It primarily comes from government support and funds raised by various businesses, research institutes and higher learning institutions, and S&T loans offered by domestic banks and financial institutions. It is commonly believed that R&D to GDP ratio is the important indicator for the intensity of S&T investment.

In the early 1990's, experts from the Chinese Academy of Sciences, State S&T Commission, State Statistics Bureau and Qinghua University organized a study group to design and compute our major S&T investment indicators. The result was adopted by the State Statistics Bureau. Since 1992, the total S&T investment and R&D to GDP ratio is officially released by the State Statistics Bureau. According to national socioeconomic reports, our R&D to GNP ratio was 0.72 percent in 1991, 0.71 percent in 1992, 0.62 percent in 1993 and 0.5 percent in 1994. Experts are complaining about this low level of S&T investment. It is primarily due to the relatively low funding for R&D in recent years. To this end, the S&T community recommends to the central government to raise the R&D to GNP ratio to 1.5 percent by the year 2000.

In the "World Science Report" released by the United Nations, China and India both spent 0.8 percent of their GDP on research. The ratio is 0.4 percent in Latin American and Middle East countries. It is 1.6 percent in developed countries in Asia and 1.7 in central and eastern Europe. There is little doubt that our investment is inadequately low.

Low funding in S&T has severely restricted basic research. Recently, a meeting was held at Xiangshan to discuss the strategy for basic research in China in the 21st century. The status of basic research in China was summarized as follows.

China is a leader among developing nations in basic research. In a few fields, we are at the cutting edge. Nevertheless, compared to developed countries and regions, there is still a large gap in terms of capital infusion, facilities, depth of research, quality of personnel and international exchange. It cannot meet the needs in economic growth. Due to shortage of funds, outdated equipment and lack of a steady supply of young professional, basic research is facing a tough time in China. We must recognize this hardship and crisis facing basic research.

Furthermore, the lack of funding also limits the commercialization of S&T results. Many of them are shelved. This is the case even at large and medium size state-owned businesses. Because of lack of funds, people are not enthusiastic about S&T. Associate Fellow Ding Gangju [0002 0474 5282] of the Institute of Technology and Economics of the State Planning Commission pointed out that some large corporations in Japan spent billions of dollars in development. In China, a large business such as Anshan Steel had retained earnings of 8 million yuan in 1991. Where do we find the money to invest in technology development and commercialization?

3. China is still feeling its way to combine S&T with economy.

As we appreciate how much S&T has improved our day-to-day activities, it only contributes 20 percent of our economic growth. It is 30 points below the level of developed nations in the 1950's and 1960's. In the U.S. and Japan, this percentage is 80 percent.

It should be pointed out that it is not that S&T itself is not powerful enough to support us to build a strong economy. Since the founding of this government, the progress in S&T is obvious. The S&T team continues to strengthen. There are numerous research institutions all over the country. We have essentially built a comprehensive S&T system. Despite the fact that China's S&T is still falling behind, the progress in S&T needs

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to be a high profile issue in our society. Since 1980, our major S&T accomplishments have been growing at an amazing rate of 25 percent per year. During the decade between 1981 and 1991, a total of 156,000 major accomplishments above the provincial level have been obtained. Since 1990, there are over 30,000 major accomplishments every year and approximately 15 percent of those are at advanced world class. In Shanghai, the number is as high as 37 percent. In addition, there are about 30,000 patents each year. In quantity, China is comparable to Japan and U.S. It is the belief of some that even if we stop research today, it won't take long for China's economy to catch up with the rest of the world if the existing accomplishments are commercialized.

However, despite a large number of accomplishments, after more than a decade of reform to modernize the commercialization process, officially only 10 percent of them are "expanded." The definition of commercialization is also very loose. In the Ministry of Machine Building, if it reaches 10 percent coverage in three to five years, it is considered "expanded." The requirement is even lower with the State Education Commission. A 4 percent coverage is considered enough. It is particularly of interest to point out that certain developed nations, including the U.S., are closely monitoring our technical accomplishments published in a number of prestigious journals. Some results are being commercialized by these countries and some products are even being shipped into China.

Why can't we turn our S&T "resources" into an economic advantage?

As a complete entity, S&T and the economy are closely tied together. What is the key issue?

An official at the State S&T Commission pointed out that although the Chinese Communist Party, the government and the entire society are focused to combine S&T with our economy and are paying attention to converting S&T results into products, however, S&T is still separated from the economy. To date, everyone recognizes that S&T is the primary force of productivity. However, in reality, it is not given first priority. Researchers are still focused on research and spending less effort on commercialization. Industry is still waiting for, depending upon and asking the government to provide results and funding. Some policy-making departments also failed to regulate and control the commercialization of S&T results because they thought in a market economy everything is market driven. In realty, even in developed countries, the government is involved in key technology development that concerns the overall economy. In developed nations, the ratio of spending on research to development to commercialization is 1:10:100.

In China, our investment is very low. Even in our most industrialized city Shanghai, the ratio of spending on research to pilot production to production in high tech companies is 1:1.03:10.55. Next, our policy is inconsistent with existing rules and regulations. For example, the agricultural S&T promotion act emphasizes networking. However, many agricultural S&T stations have been eliminated, which effectively destroys the network. Finally, some S&T results are not mature enough to be commercialized. Sometimes, they are too costly to be converted into products.

Furthermore, China adopted the S&T system of the former USSR. The entire S&T resources are poorly distributed across the country, separating S&T from the economy. Nearly 70 percent of the scientists and engineers are working at research institutions unrelated to industry. They are accountable for 60 - 70 percent of the total R&D funding. There are 18,633 large and medium size businesses in China. Their technical strength is very weak. Only about one half of these major corporations have their own development organizations (the figure is 100 percent in Japan and the U.S.). Among all the personnel in R&D, only 414,000 have a college degree or above. This is less than 30 percent of the total work force in this field. The average is 22 per company. It is a very small work force. Due to career advancement and compensation issues, people are leaving industry. How can we compete with developed nations such as the U.S. and Japan where close to 70 percent of the technical work force are employed by industry? From the standpoint of the ratio of industrial support to total R&D funding, we cannot compete with developed nations as well. This ratio is close to 70 percent in the U.S. and Japan. In China, it is 13.8 percent. In 1993, a total of 24.86 billion yuan was spend by industry on technological improvement. This is merely 56 percent of the R&D budget of Siemens. Due to lack of funding and personnel, very few items have been developed by industry in China. The average is 2.5 per business. The number of new products developed is even less; approximately 1.33 per company.

A rigid system separates research from production.

Basic research institutes under the jurisdiction of the Chinese Academy of Sciences and applied research institutes under the control of various ministries and provinces formed an independent system. It is essentially detached from the mainstream of our economy, i.e., various businesses. Each system has its way to raise funding. This situation has not improved by much even after more than a decade of reform. According to 1993

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national statistics, there are 5,400 independent research institutes in China at the county level or above.

4. It is hard to stabilize one end to open the opportunity to all.

"Stabilize one end to open the opportunity to all" is China's policy to reform the S&T system in the 1990's. Basic research is the end that needs to be stabilized by streamlining the work force to maintain our focus on a few key areas. However, it is very difficult to "stabilize" a work force of 100,000 in basic research when the government is financially weak and S&T is economy driven.

In 1992, we were excited by the fact that China's ranking for the number of papers cited in international journals rose from number 15 to 12. Compared to number 26 in 1986, the improvement is even more significant. This number seems to indicate that basic research is breaking new ground in China. However, this number also worries many experts in the field. The number of papers is indeed rising, but the quality is still less than satisfactory. Most cited references are relatively inconsequential. The number of papers breaking new theoretical ground is falling. Upon analyzing the quality of such papers, the person in charge of high tech development at the State S&T Commission pointed out that this attitude of quantity instead of quality reflects the state of mind in certain industries where everything is profit driven. On the other hand, it also shows that there is not enough fire power in R&D. These are not the only problems. Professor Zhai Zhonghe [5049 0022 0735] has been teaching at Beijing University for forty years and had over 30 graduate students. However, only a few of them remain in China. A large number of talented people would rather work in laboratories abroad. This is because of the wide gap in laboratory facilities and standard of living.

In addition to losing people to other countries, there is a shortage of people in a number of basic research fields, such as field survey and data acquisition, technical publishing and domestic scientific instrumentation industry.

Since "stabilizing one end" is difficult, what happens to "opening everything to all?" In the past decade, very little has been done to convert S&T accomplishments to commercial products after R&D was privatized. Some people are doing other business, such as restaurant and real estate, under the banner of R&D. Even with those who are engaged in technology development and transfer, it is often done on an individual basis. It usually involves a small shop, or a small factory, which integrates S&T, industry and trade into one entity. They turn years of research into cash in their own pockets. Although this kind of small scale effort is better than doing nothing in a large laboratory, however, some people believe that this merely creates income for a few and is not equivalent to linking S&T to the economy.

The entire society, especially the government, can fully understand how difficult it has been for certain individuals since we embarked on reform. Special consideration was given to S&T (and education) from the start, including bank loans and tax relief. In 1994, the State S&T Commission and the Ministry of Foreign Trade issued an order to give a research institution the authority to operate independently if it can generate $500,000 of hard currency. (A machine building business must generate $1,000,000 of hard currency for three consecutive years before it has the authority to export independently.) The intent of this policy is to create a good mechanism and environment for S&T to stimulate economic growth. However, we did not expect that this policy served as a "double insurance" for a number of research institutes. It does not take much effort for them to turn R&D results into products.

Furthermore, there is little risk and a lot of incentive. The State Council is pushing for a new concept to combine technology development oriented research institutes with industry. However, only a few such institutes chose to follow this path. Of course, some businesses cannot afford to carry a research institute. In addition, compensation level is also an issue. (For a long period of time, most research institutions were affiliated with various administrative organizations. They were ranked at least at the county level. Although certain businesses are also ranked for similar reasons, however, their ranking is usually much lower. A large corporation is usually a county level organization. This makes it difficult for a higher level research institute to fit into a corporation.) However, the most important factor is that once a research institute becomes a part of a business, it must follow the rules of a market economy. All existing incentives are no longer applicable. Who would be stupid enough to give up all the incentives and to take such a risk? Not only all independent research institutions want to remain independent, but some industry affiliated research organizations also want to become independent in order to make themselves eligible for such incentives. In addition, because of such incentives, in order to protect their own interest, some institutions are setting up barriers, such as high technology transfer platform, to prevent it from happening. They would rather keep the technology in their own small plant for their own gain than selling it to benefit the whole nation.

5. Using S&T to build China

Further development of the Chinese economy requires the support from S&T. Agriculture has to reach a new

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plateau. Traditional farming must move toward high yield, high quality and high efficiency. State-owned large and medium size corporations must improve the structure and quality of their products and must also be more efficient. This requires innovation and advancement in technology. Since the Dark Ages, science has advanced at an amazingly fast pace. This miracle is due to productivity. The need for productivity is the driving force behind progress in S&T. Today, our economy is calling for help from science. It is an excellent opportunity for S&T, as well as for economic growth.

What should we do to accelerate S&T development to build China into a modern nation?

Plan 1: increase the level of investment. In the past, the government was the only entity engaged in R&D. In a planned economy, there is no doubt that "government action" is most important. Even in market economy countries, government funded research represents a substantial portion of the overall R&D budget. The lower the degree of development, the higher this percentage is. However, judging from the success of developed nations such as the U.S. and Japan and the "Four Tigers" in Asia, and from the failure of the former Soviet Union and eastern Europe, a "centrally managed," purely government supported S&T system is not going to make it. In a developed market economy country, the society is the primary investor in R&D. The government is responsible for the planning and policy-making of research activities that are unsuited for a private enterprise to undertake.

From this angle, increasing the level of R&D funding involves everyone in the society and requires the support of everyone.

Plan 2: accelerate the pace of S&T system reform. The 5th Plenum of the 14th National People's Congress issued a policy to widen the scope of reform of the S&T system in order to build a mechanism to closely combine research, development, production and marketing together so that we can be more innovative. Following the policy of "stabilizing one end and opening it to all," the R&D system will be optimized in order to maintain a reasonable distribution of talent. To this end, some experts suggest that in order to deal with the reality and to ease the resistance against reform, we should pick up the pace to change the function and reduce the responsibility of various administrative departments of the government for a period of time in order to allow them to focus on long term basic and applied research. The branch of government in charge of economic growth should concentrate its effort to pass a corporation law. In addition to supporting business to move forward, we should also coordinate the realignment of industry structure and support basic industry and new industry in their effort to make a major or advanced technology innovation. As for issues related to duplication of effort in key national projects, we must refrain the government from getting too involved. The government should be a referee, but not a player. It should coordinate among various departments to ensure a fair arrangement. Economic and S&T departments must be aware of the roles they each play. S&T is the driving force behind economic growth and the entire society is relying upon S&T to carry the economy forward.

As for the specifics of the reform, it is commonly believed that most state-owned research institutions must be converted toward technology transfer or consolidated with an industry to become an integral part of productivity. With the exception of basic and public welfare research and major projects related to the economy, social development and defense, most other R&D activities should be regulated by the market.

Plan 3: establish a healthy market economy. We must accelerate the integration of S&T to the economy. S&T must become a part of the economy to be productive. The 5th Plenum of the NPC instructed us to strongly promote R&D results and to speed up the pace of commercialization. We must strengthen the cooperation and consolidation between research and higher learning institutions with industry. Push research institutions into becoming a part of a large corporation and encourage large corporations to establish their own research facilities. This will truly make industry the primary body responsible for technological development. Fan Hengshan [5400 1854 1472], director of the general office of the State System Reform Commission pointed out that once a healthy social market economy system is established, S&T will naturally become a part of it. This statement has been partially proven to be true. Private enterprises and companies are very enthusiastic about technical accomplishments and high technology because it is hard to survive in the marketplace without technology and innovative products. In response to market pressure, even some state-owned small and medium size companies are thirsty for technology to the extent they are not very selective. A cement factory manager in Shandong once said that what he needed most is technology, next is projects and third is capital. In his search for economically attractive S&T results, he traveled to Beijing many times. Once, he even visited China Institute of Preventive Medicine which is totally unrelated to his business. One can see in such a system there is no need for the government to promote S&T results. Adopting S&T results thus becomes an internal desire. In response to

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competition, new subjects will be addressed by S&T to meet market demand and production needs. In the meantime, S&T itself is advancing as a consequence. Research institutions and personnel must also face up to competition, just as the rest of the business community. If an institution is not cost-effective enough to meet the ever more demanding need of the market, it will be punished by the law of competition. This is what survival is all about in a market economy.

We believe that if we truly act to put S&T as the primary force behind productivity, instead of just plain talk, if we make every official and citizen be more aware of the importance of S&T so that everyone believes a strong China can be built on the foundation of S&T, we will all be generously rewarded in the future.

China's 1995 Electronic Components Exports Break $3 Billion Mark

96P30182A Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 2 Apr 96 p 5

[FBIS Translated Text] According to Customs statistics, China's exports of electronic components in 1995 totaled $3.004 billion; this amount is 6.17 percent of the nation's [1995] electromechanical-product exports and 17.65 percent of the nation's [1995] electronic-product exports. The $3.004 billion figure represents a growth of 33.63 percent over that for 1994. Among the total electronic-components exports [for 1995], printed circuits were first, at $420 million; second were fixed and variable capacitors, totaling $370 million.

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China: Ultrahard Materials Machining R&D Project Passes Acceptance Tests

963A0044A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 25 Jan 96 p 5

[Article by Liu Huilin [0491 1920 3829]: "Engineering Project of Machining Ultrahard Materials Accepted"]

[FBIS Translated Text] KEJI RIBAO Report: Recently, the "Experimental Project for Research and Development of Ultrahard Material Processing and Its Industrialization" has accomplished all its missions as specified in the Beijing Science Commission's Promotion Contract. The project was developed by the Beijing Electrical Processing Research Institute (BEPRI). Taking advantage of the ultrasonic grinding-polishing technology developed locally and abroad, coupled with BEPRI's own superior spark machining features, the BEPRI had researched and developed the technology combining the spark-ultrasonic technique with polishing, and new equipment for the technique. The research result effectively solves the machining and polishing problems of diamond, the hardest material of the world; changes China's traditional, backward mechanical grinding-polishing situation; promotes the industrial technical standard for polishing hole-type dies made with ultrahard material; and provides advanced technical assurance to the superior performance and quality of polished ultrahard material. Thus, a great leap in China's ultrahard material polishing technology is accomplished. The BEPRI is now supplying the market with equipment sets for polycrystalline diamond die machining. This brings good economic and social results.

Polycrystalline diamond, cubic boron nitride and other ultrahard materials are new materials developed in recent decades. Because of their superior properties in hardness, strength, wear resistance, and corrosion resistance, they are widely used in the fields of electrical engineering, electronics, aeronautics and space, electrical wires and cables, petroleum geology, automobiles, and agriculture machinery, as well as tools and dies.

China: CAS Institute of Metals Develops rf Method for Fabricating SIC (W-Type) Fiber

963A0044B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 31 Jan 96 p 2

[Article by Fan Guilan [5400 2710 5695]: "CAS Institute of Metals Develops RF Technology and Equipment for Fabricating SiC Fibers"]

[FBIS Translated Text] During the Seventh 5-Year Plan and the Eighth 5-Year Plan, the Institute of Metals (IOM) undertook the task of new material development, which is to produce SiC fibers by the CVD method, an item in China's High-Tech Program. After years of hard work, the IOM finally successfully developed the technology and equipment for fabricating tungsten-core silicon carbide fiber (SiC W-core) by the radio-frequency method. The technology and equipment have already been approved by the Chinese Academy of Sciences. Experts regard that the successful manufacturing of SiC fibers by the CVD method is significant in the promotion of composite utilization in China's aerospace and aeronautical domains. The SiC fiber has a bright application future in high-tech.

SiC fiber made by the CVD method is a high-tech product, characterized by high specific strength, high specific modulus, high temperature resistance, good oxidation resistance, and other superior properties comparable to those products available only in the United States and England. After repeated experiments and continuous research, the IOM personnel manufactured a prototype equipment with improved automatic production capability. The new radio frequency (RF) heating technique is successfully utilized to produce SiC(W-core) fibers with protective coating. The room temperature tensile strength of these fibers is greater than 3700 MPa; and modulus of elasticity, greater than 400 GPa. The combined properties of the fibers have reached those of the 1990s standard of similar products (made by the British BP [British Petroleum] Company) abroad.

The successful production of Si-C fibers by the CVD method changes China's situation of trying to make advanced composites without high quality reinforcement, which is like "cooking without rice." Therefore, the SiC fiber accomplishment is a significantly positive factor in the development of China's advanced composites and their related sciences.

Update on China's High-Temperature Superconductivity R&D

963A0044C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 8 Feb 96 p 5

[Article by Wang Fei [3769 4869], KEJI RIBAO reporter, Deng Yu [6772 1342], photographer: "Superconductivity: Campaign for Time and Money"]

[FBIS Translated Excerpts] The "high temperature superconductivity craze," which once spread like wild fire, vanishes suddenly like a lost myth.

Does this mean that no one wants to create a miracle, or that a storm has clipped the wings of scientists? Of course, neither is true.

Beginning from August 1995 up through December 1995, four important leading achievements in China

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have been obtained in the Superconducting Materials Research Center of the General Institute of Nonferrous Metals (SMCGINM) in Beijing. The Center is the research and development base for superconductor applications.

The first achievement is a high-temperature superconducting magnet of the bismuth system which produces a one-Tesla magnetic field at 4.2 K in liquid helium. Professor Yuan Guansen, director of the SMCGINM, commented that it would have been less significant if the strong magnetic field of this magnitude had been created by a bulk superconductor. The material, a research product of the SMCGINM, is a 100-meter-long superconducting ribbon. This achievement signifies that the material can be used to make electrical wires and generator coils for application purposes.

The second achievement is a superconducting thin film with a composition of yttrium-barium-copper-oxide (YBCO) grown on a metallic ribbon substrate. The assembly has a critical temperature of 91 K. Yuan Guansen commented that there are two basic families of high-temperature superconducting materials: the bismuth system and the yttrium system. The latter has superior properties; however, its brittleness causes difficulty in forming ribbons.

The third achievement is the fabrication of a world-standard large-scale superconducting YBCO block whose magnetic floating property reaches 8 to 10 newtons per square centimeter (N/cm^2). Professor Yuan said that we all know that like-poles of two conventional magnets repel each other, and opposite poles attract. A superconducting magnet also has these properties; however, one magnet will float on top of the like-pole of another magnet. Frictionless bearings and non-contact transportation systems such as the magnetic levitation (maglev) train can be based on this property. In 1995, an organization from Japan tried to sell this technique in eastern China. Because they did not reveal the technical details, there is no way to find out whether the idea of the maglev train could be materialized.

The fourth achievement is research progress in developing a direct current superconducting quantum interference device (DC-SQUID) by the double epitaxial method. This research establishes a foundation for developing weak magnetic-field sensors.

Certainly, these achievements represent years of gradual progress at the cost of considerable capital and enormous efforts of the research personnel. However, the above may not adequately express what these accomplishments signify. Let us review the research and development history of superconductivity and its current status abroad.

[Passage omitted] A decade later, the superconductivity fervor has gradually cooled down. Superconductor research, including research in China, has centralized in organizations which offer advanced equipment and research resources. The goal of research has moved from basic research of superconductor physical properties to practical applications. Research on the four existing copper oxide high-temperature superconducting systems including the yttrium system and the bismuth system, is now entering the technology development and application phase of materials science. We know that superconducting technology can be widely applied to important areas of national economy, such as electronics, national defense, energy, transportation, and medical technology. It will enhance computer capability beyond imagination; make possible a maglev train which travels at a speed of 500 to 700 kilometers per hour and gives a new meaning to "flying speed"; make a factory motor run quietly; etc. TIME magazine in the United States predicted that in the early 21st century, superconductors will be the second of the 10 important technologies.

However, is this technology that could be freely applied for the benefit of mankind forthcoming?

Intensive Campaign To Compete for Commanding Market Position

Superconductivity research encompasses certain basic front-end theoretical problems of condensed state physics and material science. It is also generally believed that the next few decades will bring some exciting discoveries, such as the occurrence of superconductivity at a much higher critical temperature, as high as room temperature. Moreover, the superconductor industry will greatly expand in the next 20 years; consequently, it will strongly influence the development of economy and society. Because of these factors, the superconductivity science has unquestionably become the focal point of current developments in physics and materials science. It draws global attention, and in particular controls the nerve center of science and industry.

The developed countries have aggressively converted superconductivity research results to application and industrialization. At present, the United States and Japan each invests about $100-200 million yearly in superconductivity R&D, and each of them has obtained some outstanding results. Following the U.S. ASC Manufacturing Company and the Japanese Sumitomo Company, the IGC company in the United States is also planning to build a commercial-scale production line. Thus the application development of the bismuth-system

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ribbon material is conducted by three independent outfits. In the United States, a project plan to replace an urban underground oil-cooled transmission cable system with a nitrogen-cooled superconducting cable system is in progress.

The high-level International Conference on Superconductivity Technology predicted that the world market for superconductivity technology will grow to $150-200 billion by the year 2020. Regardless of the degree of accuracy of this estimation, an attractive superconductivity technology market is forming.

What Shall China Do?

The Chinese people's ability in scientific research is recognized by the world. About half of the papers at international superconductivity conferences were read by authors of Chinese descent coming from different parts of the world. Scientists Zhao Zhongyao of the Institute of Physics of the Chinese Academy of Sciences, and Chinese-Americans Paul C.W. Chu and Maokun Wu, have accomplished global breakthroughs.

China also deserves to be recognized as a major superconductivity research nation. China has a long-standing team of R&D personnel. They work at the CAS; higher-education institutions; and research units of ministries or industries, such as the experiment-oriented CAS Institute of Physics, the theory-oriented Beijing University, and the Beijing Institute of Nonferrous Metals, which is dedicated to application research. Their research keeps abreast with international progress. Their essential work on superconductivity has reached the standards of advanced science and technology.

The present question is still how to convert research to application and industrial use. In this respect, China is behind world standards, and the gap is widening. The reasons are as simple as follows:

The technology for high-temperature oxide superconducting material is much more complicated and difficult than that for conventional metallic superconducting materials. The electrical superconducting properties of high-temperature oxide superconductors are extremely sensitive to crystal defects and chemical compositions. During the high-temperature oxide superconductor fabrication, raw material purity, heat treatment process, oxygen atmosphere, crystal growth and its structure direction, crystal boundary and second phase, etc., must be strictly controlled. The investment in the superconductor industry is very high and very risky. The large industrial conglomerates abroad, such as the Sumitomo Group and Toshiba-Kobe Steel in Japan, as well as the Krupp Group in Germany, all have abundant capital. They can afford the risk of developing new high technology. After all, this new high technology assures future industrial prosperity.

The scientific research enterprises in China still rely mostly on State funding. During the Eighth 5-Year Plan (FYP) , the State invested about 8 million yuan in superconductivity research. With a budget less than one percent that of Japan or the United States, China's research results can still closely measure up with the international standard. China's research is highly efficient; however, the amount of investment for superconductor industrialization is obviously utterly inadequate. Another concern is that even when China is good at keeping up with research progress of others, China has very few superconductivity inventions or patents. At present China has the same level of knowledge as others, and our future development is not under outside restrictions. This does not ensure that in the future, China could be free from the possible restrictions by intellectual property rights [IPR] protection of others when the superconducting industrial era comes. This is evidenced by previous experiences.

The Ninth FYP will be implemented in the last 5 years of the 20th century. We have reasons to believe that it is the crucial period for superconductivity research and industrialization, because market demand is already emerging. Taking the hydropower generation in the Three Gorges as an example, when a conventional cable is used for power transmission from the Three Gorges to Shanghai, 20 percent of the power will be lost along the route. If a liquid-nitrogen cooled superconducting cable is used, this loss can be reclaimed. China's existing bismuth-based ribbon superconductor can satisfy the preliminary technology for manufacturing electric transmission cables. It is planned that by 2000, the initial stage of R&D work to fabricate a 100-meter liquid nitrogen cooled superconducting-cable demonstrator will be completed. Based on the technology of making a small bismuth-based magnet block that was accomplished in the Eighth FYP, a complete set of technology for making experimental bismuth-based magnets will be established during the Ninth FYP. A prototype energy-storage flywheel supported by a frictionless bearing is also planned for completion during the Ninth FYP. All these projects need enormous investments.

The official superconductivity investment in the Ninth FYP will double that in the Eighth FYP. Nevertheless, this investment only reinforces experimental resources and refurbishes equipment to a limited degree. Because of this, the concerned personnel appeal that a new "Research and Technical Center for Superconducting Materials" be established as soon as possible. The Center will consolidate superconductivity research and experiment aiming at application conversion. Personnel and material resources should be centralized to improve effi-

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ciency and to speed up development. At an appropriate time, the formation of a "Superconductivity Technology Corporation of China, Limited," should be considered to draw private or business investments locally or from abroad so that superconductivity will again become a real hot topic in China.

China: Microstructure of Ti-Alloy Matrix Composite Reinforced by SiC Fibers

96P30184A Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Mar 96 Vol 32 No 3, pp 318-322

[Article by Yu Liguo [0060 4539 0948] et al. of the Laboratory of Atomic Imaging of Solids, CAS Institute of Metals Research, Shenyang 110015; MS received 8 Jun 95, revised 5 Dec 95]

[FBIS Summary] In 1992 the U.S. firm Textron set up a SiC fiber/Ti matrix composite production line for making aircraft wings, fuselage sections, and engine parts. Recognizing the many advantages of this composite, the authors have conducted a study of the microscopic structure of Ti-alloy matrix composite reinforced with 120-μm-diameter SiC fibers. Results of the study show that (1) β-SiC dendrites grow along the radial directions perpendicular to the 15-μm tungsten core, (2) many stacking faults and microtwins are formed within the dendrites, (3) SiC fibers bond well to the matrix, and (4) the amorphous interfacial layers between them are not damaged during composition. In the course of composition, the SiC dendrites near the interfacial region dissolve and diffuse into the amorphous layer and react with the Ti-alloy matrix at high temperature, producing TiC and Ti_5Si_3.

The SiC fibers, made at the CAS Institute of Metals Research, are manufactured with an rf heating CVD [chemical vapor deposition] technique involving exposure to a mixture of chlorosilane and hydrogen gases continuously passed through the reactor. The Ti alloy (Ti-15V-3Al-3Sn-3Cr) is pressed into a thin plate onto which are bonded the SiC fibers, forming a multilayer sandwich pattern. This material is then hot-pressed for 30 minutes under a pressure of 40-50 MPa at a temperature of 900-950°C with a vacuum of 0.01 Pa. The composite samples are then cut with a linear cutter along the fiber transverse direction into 0.2-mm-thick plates, which are then mechanically polished down to 50-micron-thick plates. These plates are then stamped into 3-mm-diameter pieces. A pitter is used to dig a pit in the central portion of the samples, which are thus reduced to 20-25 microns in thickness. This is followed by processing with an LBS-1 5-kV, 0.4-mA Ar-ion reducer and other steps. The β-SiC fibers have an fcc (face-centered cubic) diamond structure with dot-matrix constant a = 0.436 nm, fiber length of about 1 micron, and 100-nm transverse dendrites.

Eight figures, not reproduced, show the low-and high-magnification morphology of the fibers, an electron diffraction pattern of the large-scale dendrites, an HREM image of the fibers, morphology of the SiC/Ti interfacial region, dispersive β-SiC particles in the amorphous layer, morphology of the interfacial reaction region, an HREM image of the TiC and corresponding electron diffraction pattern, and an HREM image of the Ti_5Si_3 and corresponding electron diffraction pattern. There are no tables. References: 6 English (including 1 by same authors), 1 Chinese.

China: MLC Low-Temperature-Sintered Y5V203 Material Passes Acceptance Tests

96P30184B Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 9 Apr 96 p 1

[Article by reporter Li Wansang: "Major Breakthrough Reached in China's Production of Ceramic Materials"]

[FBIS Summary] The "MLC (multilayer ceramic) low-temperature-sintered, high-performance Y5V203 ceramic" developed in an 863 Program major research project and converted into production by Fenghua High & New Technologies Ltd. in Zhaoqing [Prefecture], Guangdong [Province], recently passed SSTC-organized acceptance tests. This material was jointly developed in 1994 by Qinghua University, Xian Jiaotong University, the CAS Shanghai Institute of Ceramics, and MEI Institute 715, and then transferred to Fenghua in March 1995 for secondary development and industrial production. Since that time, the material has been in mass production and has entered the international market: batches have been exported to the U.S., the Netherlands, and other countries. Testing and practical application have shown that this ceramic's overall technical performance and quality meet or exceed standards set by the comparable U.S. and Japanese ceramics used in high-performance, low-temperature-sintered MLC capacitors.

China: Large-Size Tl:CsI Crystals To Be Exported to U.S., Japan

96P30184C Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 15 Apr 96 p 1

[Article by reporter Huang Xin]

[FBIS Summary] Chinese scientists have realized a major breakthrough in research on scintillation crystals

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[used in scintillation counters]: large-size, high-performance thallium-doped cesium iodide (Tl:CsI) crystals, developed over a 2-year period by the CAS Shanghai Institute of Ceramics (SIC), are to be exported to the U.S. and Japan. This marks another major breakthrough following upon the SIC's mid-80s development of bismuth germanate (BGO) crystal and 90s development of cerium fluoride (CeF_3) crystal. SIC has signed separate agreements with Stanford Linear Accelerator (SLAC) authorities, building the BaBar electromagnetic calorimeter(s), and Japan's Institute of High-Energy Physics (KEK) authorities, building the Belle electromagnetic calorimeter(s), for export of the Tl:CsI crystals. Large quantities of this crystal are needed at these U.S. and Japanese facilities.

China: Research on Damping Characteristics of NiTi Shape Memory Alloys

96P30186A Dalian DALIAN LIGONG DAXUE XUEBAO [JOURNAL OF DALIAN UNIV. OF TECHNOLOGY (DUT)] in Chinese Mar 96 Vol 36 No 2, pp 189-192

[Article by Wang Jijun and Ma Xiaojiang of the DUT Research Institute of Vibration Engineering and Cui Lishan, Chen Feixia, and Yang Dazhi of the DUT Dept. of Materials Engineering, research supported by grant from NSFC; MS received 4 Sep 95, revised 20 Dec 95]

[FBIS Summary] Shape memory alloys (SMAs) are an important, promising class of intelligent materials. In this paper, the dynamic damping characteristics of NiTi SMAs in the B2 parent phase are systematically studied by using the phase-measurement method. Experimental results show that the maximum value of damping (Q^{-1}) for the NiTi SMA in the parent phase is on the order of 10^{-1}. With increasing vibration frequency, damping significantly decreases. When this frequency exceeds the critical value f_0 [= 10 Hz], damping is relatively small and stays at a certain stable value. Within a certain range, damping increases with increasing amplitude and also increases with increasing pre-strain.

The experimental sample was a 0.5-mm-diameter NiTi alloy thread with a scale distance of 80 mm and a very small mass. A shock test was done with an American-made MTS810 materials tester, which has high-accuracy force and displacement sensors (freq. range of 0.1-200 Hz). Measurements of force and the phase angle of the shift were done with a Japanese-made CF-350 dual-channel FFT analyzer. Specific values for damping were as follows:

- In the ultralow-frequency (0.10-0.25 Hz) band, Q^{-1} = 0.095
- In the low-frequency (0.25-9.5 Hz) band, Q^{-1} = 0.5-0.6
- In the narrow-band range of 9.5-10.0 Hz, Q^{-1} drops down to 0.02
- In the 10 Hz-and-higher range, Q^{-1} remains at 0.02

Four figures, not reproduced, show a schematic of the phase meter and operating principle, a graph of the influence of vibration frequency on damping, three plots of the influence of amplitude on damping, and a schematic of the theoretical analysis model. The one table, not reproduced, lists values showing the influence of pre-strain on damping.

References: 2 Chinese (1980s books by researchers at DUT and Xian Jiaotong University), 2 English.

China: Shape Memory Materials Associated With Martensitic Transformations

96P30186B Shanghai SHANGHAI JIAOTONG DAXUE XUEBAO [JOURNAL OF SHANGHAI JIAOTONG UNIV.] in Chinese Mar 96 Vol 30 No 3, pp 8-15

[Article by CAS Academician Xu Zuyao (T.Y. Hsu) of the Dept. of Materials Science; MS received 29 Dec 95]

[FBIS Summary] Characteristics of materials possessing the shape memory effect (SME) induced by martensitic transformations are summarized. These characteristics include the thermodynamics of thermoelastic martensitic transformation; thermodynamic calculation of M_s [martensite starting point] temperature; and the SME of various materials such as NiTi, Cu-matrix alloys (especially Cu-Zn-Al), Fe-Mn-Si-matrix alloys, and ZrO_2-containing ceramics. Finally, a brief perspective on the development prospects for SME materials is given.

There are no figures or tables. References: 18 Chinese, 22 English (including 18 by the author).

China: Preparation, Nature of Ferroelectric-Metal Nanocomposite

96P30186C Beijing KEXUE TONGBAO [CHINESE SCIENCE BULLETIN] in Chinese 16-31 Mar 96 Vol 41 No 6, pp 569-572

[Article by Zhou Ji, Li Longtu, Gui Zhilun, and Zhang Xiaowen of the Dept. of Materials, Qinghua University, Beijing, research supported by grant from State Post-Doctoral Science Foundation; MS received 6 Feb 95, revised 1 Jun 95]

[FBIS Summary] A sol-gel process is used to prepare several types of ferroelectric-metal nanoparticle composite thin-film materials, and an initial study of the structure and nature of these new material systems is

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conducted. In the present paper [designed as the first of a series], results for the $Ag/BaTiO_3$ (silver/barium titanate) system are reported.

Raw materials include $Ba(O\text{-}iPr)_2$ made by Britain's Inorg Tech Company, $Ti(O\text{-}iPr)_4$ made by the American firm Strem Chemical, $AgNO_3$ made by the Beijing Chemical Engineering Plant, and $CH_3O(CH_2)_2OH$ made by the American firm Aldrich Company. All of these reagents are analytical-grade. Testing was done with a Philips CM20 TEM/STM for electron microscopy, a Philips MPD-1880I powder X-ray diffractometer for X-ray diffraction analysis, a Philips PU8700 UV-visible spectrometer for absorption spectrographs, and an RT-66 ferroelectric analyzer for measurement of dielectric constant. A table lists Ag particle diameters ranging from 1.3 nm for a processing temperature of 300°C (with a dielectric constant of 3.3) to 14.2 nm for 600°C (dielectric constant = 37.4).

Figure 1, not reproduced, is a TEM micrograph of a 0.005 mol $Ag/BaTiO_3$ thin film (with 2-3-nm Ag particles) after heat treatment at 400°C. Figures 2 and 3, not reproduced, show the X-ray diffraction spectrum and absorption spectrum, respectively, for this same film at heat-treatment temperatures from 300-600°C. The one table is summarized above.

References: 5 English, 1 Chinese.

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China: Xian Institute's Interpretoscope Aids LM-2E's Launch of Asiasat-2

963A0058A Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 23 Feb 96 p 1

[Article by reporter Wang Baizhan [3769 4102 2069]]

[FBIS Translated Text] The Xichang Satellite Launch Center sent a congratulatory cable to the Xi'an Institute of Optics and Fine Mechanics (XIOFM) expressing high praise for the "GP-27 universal interpretoscope" developed by the Institute. This device was used during the recent successful launch of Asiasat-2 by the LM-2E strap-on heavy space launch vehicle, and made an important contribution by supplying timely, accurate and reliable data fully complementary to the successful completion of the mission.

The "GP-27 universal interpretoscope," a new kind of photointerpretation equipment that was successfully developed in 1995 by scientists and technicians at XIOFM, is the replacement equipment for China's range interpretation instruments. It uses advanced planar CCD image processing technology, and high-precision projection of digitized measurements and standard software technology. The optical system of the former interpreter has been simplified, increasing the reliability and accuracy of the interpreter's off-range measurements, and making the automatic readout of the dot-matrix code quick and nimble. It has good adaptability and versatility, is easy to apply and use, its optical projection image is clear, and not only can it interpret dot-matrix coded 35mm film of every specification, but its accuracy rate is greatly increased. This equipment has a rational structural design that is fully functional, and it is easy to debug and maintain. Experts believe that this successfully developed and applied equipment will have real and significant utility in raising the level of automation and quality of interpretation in optical measurement and digital processing.

The equipment can also have wide application in other fields of scientific research, sports, geology, and prospecting, and will be a great benefit to the society and the economy.

China: All-Weather Airborne Remote Sensing Real-Time Transmission System Described

963A0058B Beijing BEIJING KEJI BAO [BEIJING SCIENCE AND TECHNOLOGY NEWS] in Chinese 4 Mar 96 p 5

[Article by reporter Li Jinghua [2621 7234 5478]]

[FBIS Translated Text] The all-weather airborne remote sensing real-time system, a high-tech system that has been developed over the last several years, encompasses system engineering in the fields of remote sensing, radar, communications, and image processing.

In the late 1980s, the U.S. and other advanced countries began to study civil applications for this sort of system, and in 1987 the U.S. National Aeronautics and Space Administration (NASA) allocated funds and commissioned the Jet Propulsion Laboratory to study the feasibility of operating a real-time major forest fire monitoring system, and later drew up long-range plans to set up in the early 1990s a real-time flash-fire surveillance system that would be capable of monitoring for flash forest fires any time and place in the country. Japan, Canada and several European countries are also studying the establishment of airborne remote sensing real-time systems for monitoring fire disasters.

In 1987, under the unified leadership of the State S&T Commission, the Ministry of Water Resources, CAS, No. 1 Airborne Remote Sensing Department of the State Remote Sensing Center, and the State Bureau of Surveying and Cartography collaborated in advancing a plan for real-time flood disaster monitoring. Starting in 1987, tests along various technological lines were conducted on the Yongding He, Huang He [Yellow River], Chang Jiang [Yangtze River], and Huai He, and near-, medium-, and long-range real-time, or all-weather near real-time air-borne remote sensing information systems effective for up to 4-hour periods were set up. These systems had very important roles to play in monitoring the colossal floods that occurred in China in 1991.

Chinese research on the airborne remote sensing real-time system was done using an airborne remote sensing real-time transmission system that was developed and set up by the No. 1 Airborne Sensing Department of the State Remote Sensing Center based on the synthetic aperture side-looking radar (SLAR) and carrier equipment that the Center had imported. The system not only has all-weather remote sensing capability, but it has real-time transmission to a ground command center that enables the command center to view the radar images of the remote sensing area at the same time that the aircraft is creating them.

The system includes three sub-systems:

1. an aeronautical satellite communications sub-system;

2. an airborne SLAR real-time imaging sub-system;

3. a SLAR imaging ground-station processor, display and recording sub-system.

The aeronautical satellite communications sub-system, the core of the whole system, was a tough development

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task. It is used for data compression of the images obtained by the airborne SLAR real-time imaging sub-system at a data compression rate of 64Kb/S, after which they are transmitted via satellite to the ground command center.

The real-time image processing system is a key part of the system set up. It takes the real time data obtained by the airborne SLAR, converts them to images on board, and sends them over the aeronautical satellite communications sub-system, thereby facilitating their transmission to the ground command center.

The ground, display and recording sub-system for the SLAR images is also an important part of the system. It is used for real-time display, real-time recording, and real-time processing of the images transmitted back to provide a scientific basis for making command decisions.

The all-weather real-time airborne remote sensing system can play a genuinely significant role in real-time monitoring during natural disasters, so prevalent in China. This is especially so for flood disasters, which cause great losses of life, property and economic resources every year. Many years of experience have shown that floods occur in foul weather, and many serious disasters occur at nighttime; only through the use of this sort of system can real-time monitoring be done to help the country to take effective and timely actions for flood disaster prevention, and a basis be provided for making policy decisions that will reduce the loss of life and property.

China's 15th Recoverable Satellite Falls into Atlantic

96P30187A Beijing HANGKONG ZHISHI [AEROSPACE KNOWLEDGE] in Chinese Apr 96 No 4, p 4

[FBIS Summary] On 12 March [1996] China's fifteenth recoverable satellite fell into the southern Atlantic Ocean (S lat. 23°, E long. 20° [as published]). The satellite, which did not create any danger at the time of its fall, was launched on 8 October 1993 from an LM-2 space launch vehicle. This satellite was the nation's 15th scientific observation and technological experimentation satellite. On 16 October 1993, after operating in its preassigned orbit for 8 days, this satellite lost control and veered off track. The satellite was then tracked for over 2 years by astronomers at the Zijinshan Observatory. After 916 days and 11,810 orbits of the Earth, the satellite then fell into the Atlantic on 12 March 1996 at a point very close to that predicted by the Zijinshan astronomers in November 1995.

China Implements "Space Solar Telescope" Project

96P30187B Beijing HANGKONG ZHISHI [AEROSPACE KNOWLEDGE] in Chinese Apr 96 No 4, p 4

[FBIS Summary] A project with century-spanning significance—China's "space solar telescope"—is now being implemented. This solar telescope construction project, which has no international precedent, has drawn the attention of astronomers worldwide. The project is led by CAS Academician Ai Guoxiang [5337 0948 4382], Director of the Huairou Solar Observation Station at the Beijing Observatory. The 1-meter-aperture solar telescope has a budget of $45 million, to be used for satellite launch and major technical support. Scientists and engineers from the German Space Agency [DARA] and the Max Planck Institute have now begun cooperative pilot research with Chinese scientists and engineers on this world's most advanced solar telescope.

The scientific objective of this new telescope is to study processes on the scale of the solar "cell," i.e., solar magnetic field processes in a solid angle of 0.1 second. Compared to the Hubble Space Telescope, China's planned space solar telescope—at the same 0.1-second angle—can be used to observe intense-light celestial bodies such as the sun.

It has been learned that this space project has been granted a $1.5 million loan, to be used for construction of a prototype and for the first flight experiment, to be conducted via balloon in June this year.

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USTND Develops Open High-Speed Network Interface, Software Platform

96CE0108A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 22 Nov 95 No 45, p 2

[FBIS Translated Text]

Dispatch filed by JISUANJI SHIJIE special correspondent Tan Keyang

A national Eighth FYP pilot research project was recently unveiled and reviewed favorably at a technological appraisal meeting on Oct 31 in Changsha. The project, entitled "Research on an Open High-Speed Network Interface and Software Platform" represents another new accomplishment in high-tech computer research under the national Eighth FYP pilot research plan. The appraisal committee found the overall layout of the system to be advanced and technically sound while conforming to pertinent international standards. The system's hardware and software are stable and dependable. This is an open high-performance network application development platform. This accomplishment has a wide sphere of possible uses in development of the national economy and in national defense.

This is a project of the Computer Science Institute of the University of Science and Technology for National Defense (USTND). The most important breakthroughs achieved by the project task force were the implementation of an intelligent Fiber Distributed Data Interface/ Extended Industry Standard Architecture (FDDI/EISA) network and drivers that operate under the preferred Unix operating system. The system is geared towards the implementation of the high-performance servers, workstation peripheral component interconnect (PCI) buses and the Ethernet access methods used in the latest system architectures. The system also is geared towards new technologies such as the RAW-Socket interface for the latest network application programs featuring multimedia and video computing capabilities.

CAS Institute of Semiconductors Unveils China's First Neurocomputer

96CE0108B Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 29 Nov 95 No 46, p 1

[FBIS Translated Text]

Dispatch filed by JISUANJI SHIJIE reporter Guo Linxia

China's first analog-digital hybrid neurominicomputer, the "Yuyan Shen Type I," has been successfully developed at the CAS Institute of Semiconductors. The minicomputer performs 20 million operations/second. Recently it was certified during a technological appraisal that was chaired jointly by CAS and the Ministry of Electronics Industry (MEI). This project represents an accomplishment that exceeds the development targets in the special subject area entitled "Implementation of Neural Network Hardware" under the national Eighth FYP for dealing with key technological problems. The project is also one of the CAS Semiconductor Institute's four priority projects for dealing with key technological problems.

According to a official briefing, since neural networks created an international sensation in the 1980's, artificial neural networks have been used extensively in a wide range of artificial intelligence applications including pattern recognition, signal processing and economic market forecasts as well as character, image and voice recognition. Under the leadership of China's famous scholar and CAS academician Wang Shoujue, a task force has carried out research and analysis and found that due to the extremely wide disparity between the level of China's technology and engineering expertise compared to foreign countries, it is necessary to find an alternative route to success in the development of China's computer industry and to innovate daringly in the areas of design theory, design methodology and engineering.

Because traditional simulations are for the most part mathematical simulations based on software simulation and digital computations, they are slow and inconvenient to use. Furthermore, the ultra-large-scale integration (ULSI) high-speed computation chips found in multiple-machine parallel systems are extremely expensive. For these reasons, researchers have been hoping for some new ideas and methodologies to solve this problem. Wang Shoujue and his task force have put forth a new neural computation methodology, i.e. a multielement logic circuit that combines analog and digital technology. This is a solution that may be implemented using a neural network. This solution allows the computer to imitate the human learning process, that is, the computer has "artificial intelligence." Moreover, this solution gives results that best approximate actual objective reality. The technology used in this methodology includes a hybrid analog-digital application-specific processing circuit that is combined with a general-purpose large-scale integrated memory circuit. The hybrid multiplier serves as the basic computing device in the neural network and uses a high-speed fuzzy logic circuit to multiply analog and digital quantities. The general-purpose large-scale integrated memory device features high-speed static random-access memory (SRAM). This memory device is used to store a large number of synaptic weightings and the status of neurons as well as sample input values and various types of variable network parameters and neuron model topology parameters. By these means, the goal of producing a computer that is flexible and convenient to use has been achieved, with

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high performance delivered for the dollar. Compared to the digital method of computing, this method avoids the need for the expensive chips used in high-speed parallel digital computing. Because of this, the operating speed may be increased by two orders of magnitude and it is possible to greatly increase the network's performance for each dollar spent.

Building on the foundation of hybrid analog-digital multiplier neurons and analog-digital hybrid computing components, the task force has successfully developed analog-digital multipliers in a multi-element logic circuit architecture that forms a synaptic neurominicomputer. This is an innovative accomplishment in the field of neural network hardware implementation and also serves to verify the practical value of neurons and computing components that feature hybrid analog-digital technology.

This analog-digital hybrid neurominicomputer uses only four neuron synapses concurrently and achieves the high operating speed of 20 million operations/second at the neuron interconnections. Each analog sampling operation covers a range of 256 neurons X 128 samples. Each neuron has 512 synapses. The input space has 256 dimensions. The operating speed at each neuron synapse is 5 million operations/second, far higher than the operating speed of the Gilbert multiplier used abroad.

The overall architectural design of this machine suggests a general principle to be followed in the design of neural networks; namely, parameters such as the neural network's topological structure and the nonlinearity, portability, and threshold value for each neuron should all be stored in RAM as variable parameters. While the computer is running, these values may be adjusted as desired, thus facilitating flexibility and the ability to make changes quickly. Experts believe that this type of neurocomputer architecture represents pioneering work on the international stage.

This achievement will have a great effect in China on many aspects of teaching, scientific research and development in the fields of artificial neural networks, chaos theory, modelling, computing methodology, application-specific solid-state neural network chips and approaches to new applications.

First Nuclear Power Plant Full-Range Simulator Passes Acceptance Tests

96CE0108C Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese 29 Nov 95 No 46, p 21

[FBIS Translated Text]

During July and August of 1995, members of the Chinese nuclear power industry were in high spirits over the victories that had been achieved as reports of success kept pouring in. The state certification of the Zhejiang Qinshan Nuclear Power plant, China's first independently designed and constructed nuclear power plant, was followed on Aug 19 in Zhuhai by product certification and State Torch Program certification of China's first complete nuclear power plant full-range simulation system, the Qinshan 300 MW Nuclear Power Plant Simulator. This simulator was successfully developed by Asia Simulation and Control Systems Corporation, Ltd (Zhuhai Branch) after 33 months of concentrated effort. The project was carried out under the auspices of the China National Nuclear Corporation (CNNC) and the Qinshan Nuclear Power Corporation which both provided assistance and support. This project fills a technological gap in China's nuclear power industry as far as the lack of nuclear power plant full-range simulators. In one stroke, China has become one of the few countries on the international stage who can manufacture and supply this kind of system.

It is generally known that a nuclear power plant is a facility that can provide huge amounts of nuclear energy for peaceful purposes. The safety and dependability of such a facility is of the utmost importance. The simulator will enable the nuclear plant operators and technical and administrative personnel to oversee, analyze, weigh and process large amounts of control information as well as providing expertise in reactor startup, reactor shutdown, normal operation, fault operation and the handling of emergency accidents, thus increasing the ability to meet every contingency and emergency. For these reasons, whether we are talking in terms of the safety laws and regulations governing nuclear power or in terms of practical significance, the need for this nuclear power plant simulator is plain to see.

Asia Simulation and Control Systems Corporation, Ltd (Zhuhai Branch) and Qinshan Nuclear Power Corporation signed the "Qinshan 300 MW Nuclear Power Plant Full-Range Simulator Contract" in late 1992. By employing numerous academic disciplines, advanced systems technology and true-to-life simulations, this simulation system provides real-time simulation of the Qinshan Nuclear Power Plant target that is comprehensive in the range and the processes covered and highly descriptive of the actual plant. Every feature and technology in the system either meets or exceeds the internationally recognized ANSI/ANS 3.5 standards. In all respects, this system reflects the level of China's applied simulation technology and applied nuclear technology.

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China: Visual Perception Method for Detection of Small Targets on Sea Surface

96P30170A Wuhan HUAZHONG LIGONG DAXUE XUEBAO [JOURNAL OF HUAZHONG (CENTRAL CHINA) UNIV. OF SCIENCE AND TECHNOLOGY (HUST)] in Chinese Feb 96 Vol 24 No 2, pp 29-32

[Article by Sang Nong [2718 6593], Zhang Tianxu [1728 1131 1645], Wei Luogang [7614 3157 0474], and Wang Guoyou [3076 0948 2589] of the Institute of Pattern Recognition and Artificial Intelligence, HUST, Wuhan 430074, supported by grant (69175001) from the NSFC and by a grant from the State Education Commission's Ph.D. Key Fund; MS received 17 Jul 95]

[FBIS Summary] To automatically detect small targets on the sea surface, an approach adopting a visual-nonlinearity-based image segmentation technique [ref. 1] is proposed. An algorithm for the automatic adjustment of the optimal segmentation region is developed [ref. 2] and used to generate fairly good segmentation results. Then a priori knowledge of the existence of a fairly sharp contrast between the possible targets and the background is used to determine the true targets from the segmented binary images. As the algorithm can deal with either bright or dark targets, it is insensitive to the variation of the target gray levels. The effectiveness of the algorithm proposed is proved by a large number of experimental results.

Three figures, reproduced below, show a plot of the nonlinear response of vision, experimental results of at-sea detection of small dark targets, and experimental results of at-sea detection of small bright targets, respectively. Relevant parameters for the experiments are as follows:

- image size = 128 x 128 pixels
- $\mu_T = 100$
- $\rho_T = 0.45$
- $C_1 = 3$
- $C_2 = 10$
- initial segmentation size = 16 x 16
- $A_{max} = 48 \times 48$
- target minimum area threshold = 6

There are no tables.

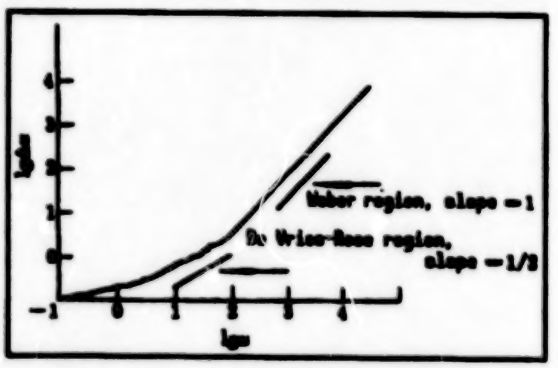

Figure 1. Nonlinear Response of Vision

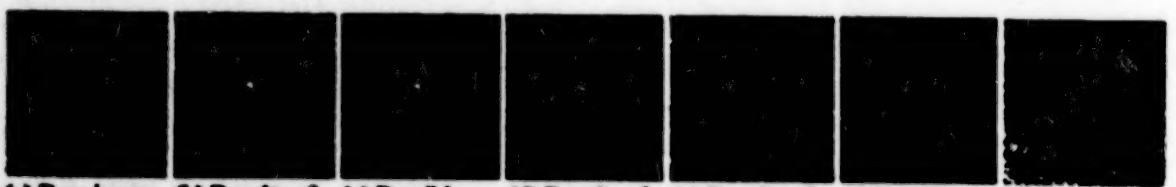

Figure 2. Experimental Results of At-Sea Detection of Small Targets (dark targets)

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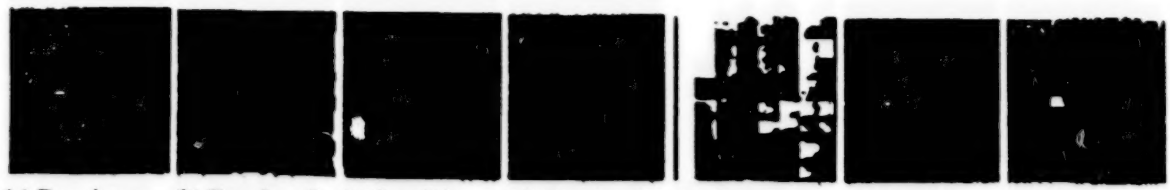

Figure 3. Experimental Results of At-Sea Detection of Small Targets (bright targets)

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China: Study on Hough-Transform-Based Shape Analysis of Underwater Targets

96P30171A Hefei MOSHI SHIBIE YU RENGONG ZHINENG [PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE] Vol 8 No 4, Dec 95 pp 351-356

[Article by Xu Gongwen [1776 0361 2429] of the Institute of Software, CAS, Beijing 100080, and Xu Wen [1776 2429] and Zhu Weiqing [2612 4850 1987] of the Institute of Acoustics, CAS, Beijing 100080, supported by grant from the CAS Institute of Automation's Pattern Recognition State Key Laboratory; MS received 20 Dec 94, revised 16 Sep 95]

[FBIS Summary] After image segmentation and region edge extraction of partially occluded or incomplete sonar images of warships, a new shape-analysis method—based on the Hough transform—is used to improve identification of these images. Specifically, the Hough transform uses an ellipse or torus to fit the warship target pattern and extract its features. The results show that this improved Hough transform method is useful for underwater object analysis and identification.

Four figures, reproduced below, show a flow chart for the underwater-target search operation, pictures of the image-segmentation and edge-detection processes, shape analysis for a partially occluded warship image, and shape analysis for an incomplete warship image, respectively. The one table shows computations of the ellipse's semi-major axis a, semi-minor axis b, and the ratio a/b.

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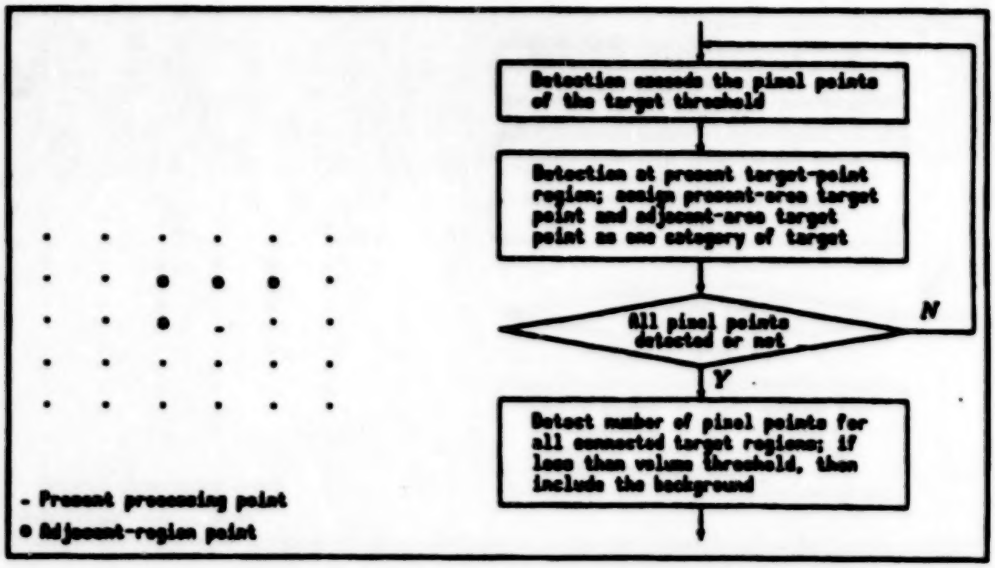

Figure 1. Flow Chart for Underwater-Target Search Operation

(a) Raw image (b) Results of image segmentation (c) Results of edge detection

Figure 2. Image Segmentation and Edge Detection

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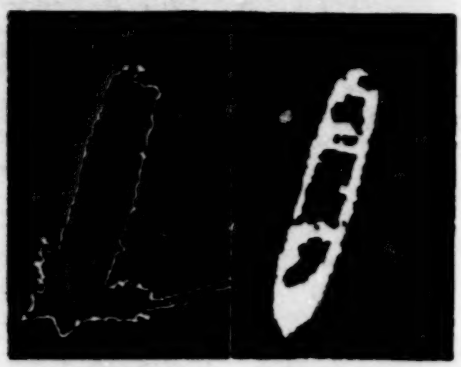

(a) Outer edge (b) Final results

Figure 3. Shape Analysis of Partially Occluded Warship

(a) Raw image (b) Results of image segmentation (c) Final results

Figure 4. Shape Analysis of Incomplete Warship

Table 1. Estimation of Values for a, b, a/b

Computation number	a	b	a/b
1	177	72	2.46
2	173	58	3.07
3	175	51	3.43
4	183	38	4.82
5	158	37	4.27
6	161	36	4.47
7	161	35	4.60
8	161	35	4.60
9	161	35	4.60
10	161	35	4.60

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China: Low-Frequency, Broadband, High-Power, Free-Flooded, Mosaic Cylindrical Transducer Described

96P30171B Beijing YINGYONG SHENGXUE [APPLIED ACOUSTICS] in Chinese Jan 96 Vol 15 No 1, pp 30-34, 25

[Article by Xie Chaoju [6200 2600 4251] of Northwest Polytechnical University (NPU), Xian 710072, and Yao Guohua [1202 0948 5478] of State-Run Plant 613; supported by grant from State Education Commission's Ph.D. Key Fund; MS received 31 Oct 94]

[FBIS Summary] The design, manufacturing process, and experimentally measured performance results for a low-frequency, broadband, high-power, free-flooded, mosaic cylindrical transducer used in a variable-depth sonar system are described.

Eleven figures, reproduced below, show a schematic of the transducer structure; a graph of the effect of the relative volume of aluminum strips on the mosaic cylinder's performance; curves of the transducer's conductance measured in air and water; a graph of the frequency characteristics for the transducer's transmitter voltage response level; a graph of the frequency characteristics for the transducer's receiver sensitivity; the transducer's horizontal directivity plot measured at f = 3 kHz; and the transducer's vertical directivity plots at f = 3 kHz, 4 kHz, 5 kHz, 6 kHz, and 7 kHz, respectively. There are no tables.

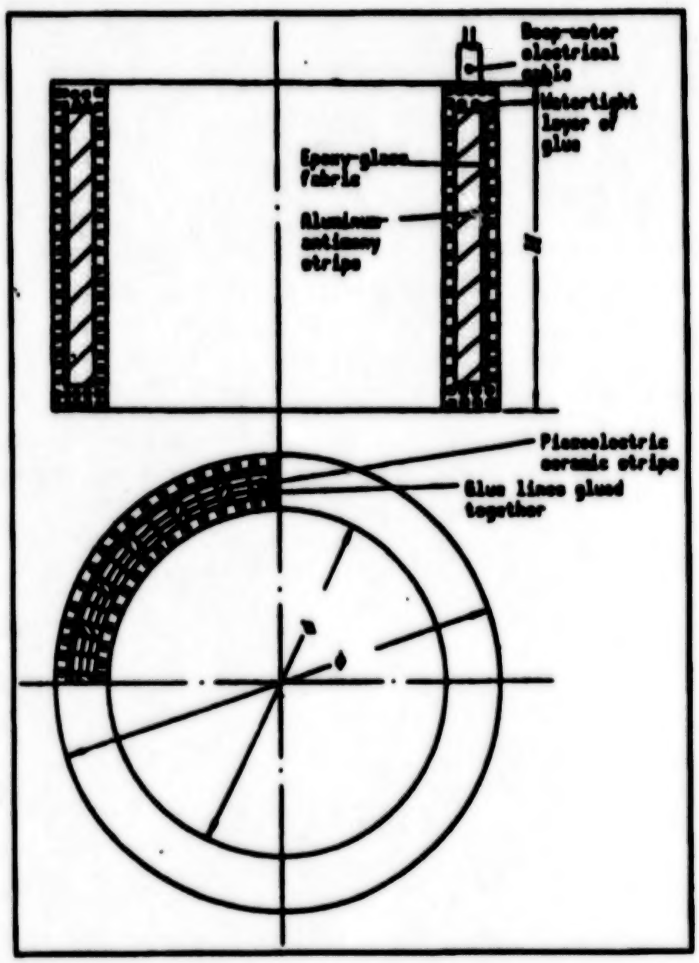

Figure 1. Schematic of Transducer Structure

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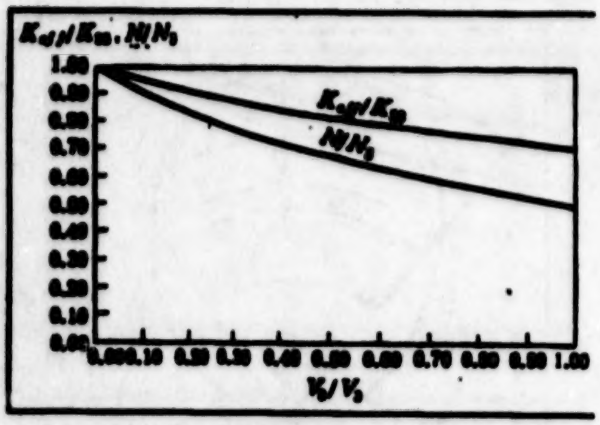

Figure 2. Influence of Relative Volume of Aluminum Strips on Mosaic Cylinder's Performance

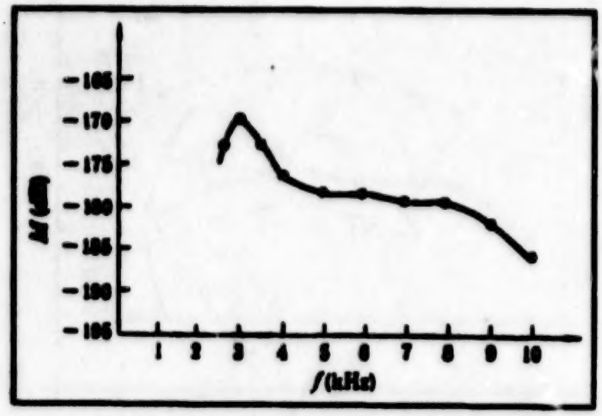

Figure 5. Curve of Transducer's Receiver Sensitivity vs Frequency

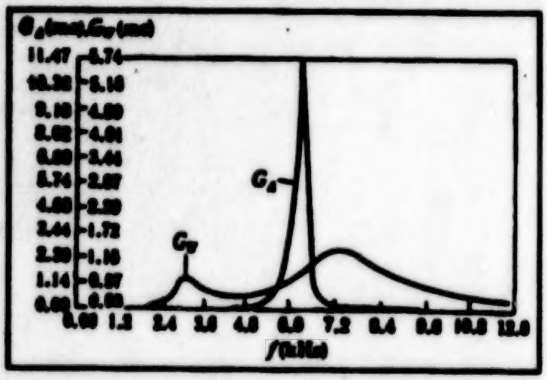

Figure 3. Transducer's Conductance Measured in Air (G_A) and in Water (G_W)

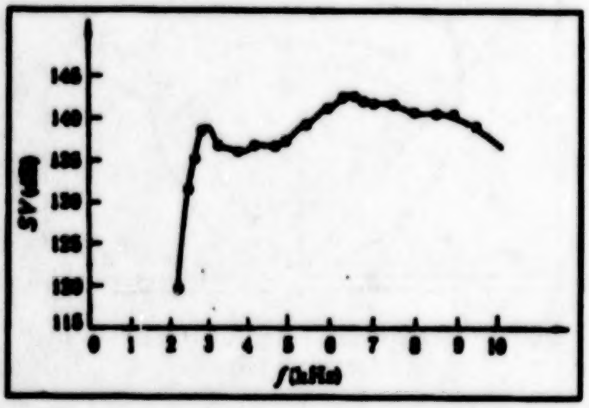

Figure 4. Curve of Transducer's Transmitter Voltage Response Level vs Frequency

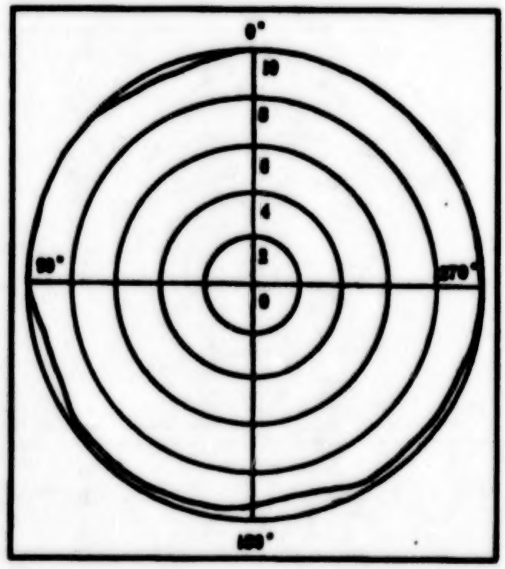

Figure 6. Transducer's Horizontal Directivity Plot Measured at f = 3 kHz

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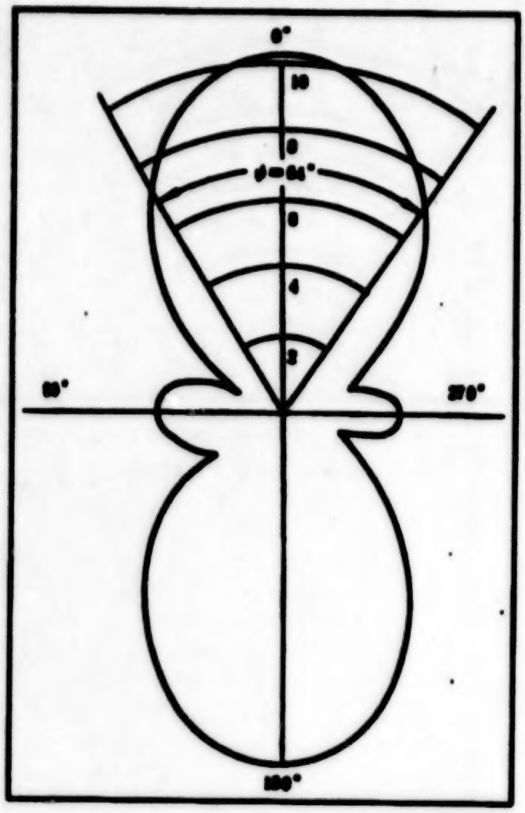

Figure 7. Transducer's Vertical Directivity Plot for f = 3 kHz

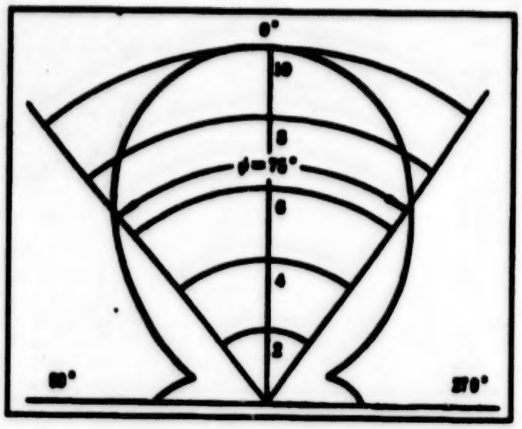

Figure 9. Transducer's Vertical Directivity Plot for f = 5 kHz

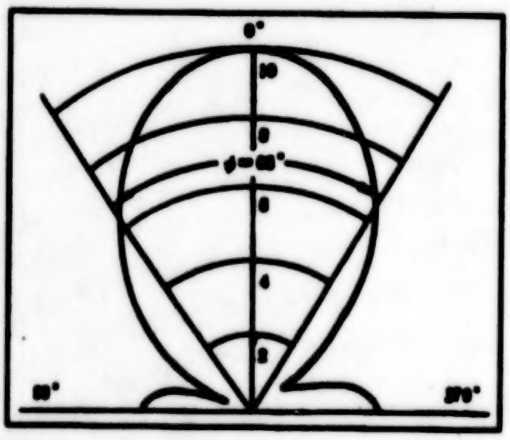

Figure 8. Transducer's Vertical Directivity Plot for f = 4 kHz

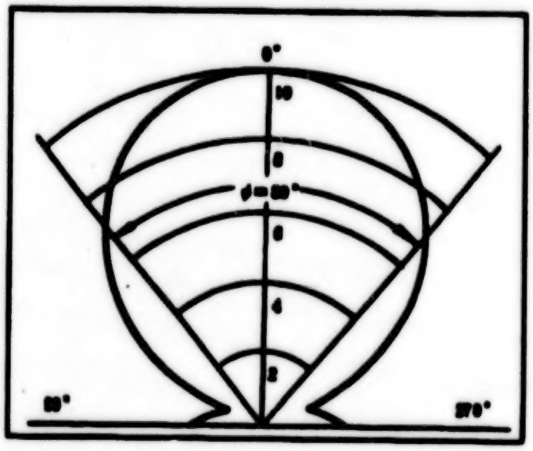

Figure 10. Transducer's Vertical Directivity Plot for f = 6 kHz

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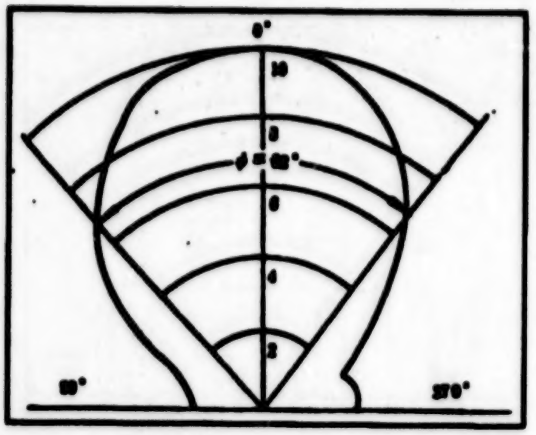

Figure 11. Transducer's Vertical Directivity Plot for f = 7 kHz

In the fabricated prototype transducer, PZT-8 piezoelectric ceramic strips and hard aluminum strips were mosaically interspersed to form the toroid, which was then sealed with a polyurethane coating. Outer diameter of the free-flooded torus is 168 [mm], inner diameter is 166 [mm], and height is 125 [mm]. The prototype transducer has undergone performance testing at the National Defense Class-1 Hydroacoustic Measurement Station. On-lake and at-sea testing has verified its excellent performance. The transducer has been successfully integrated into a variable-depth sonar and is also being promoted for use in studying acoustic remote control and other technological fields.

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China: Design, Simulation of Servo System for Azimuth Angle in Mine-Hunting Sonar Array

96P30171C Shanghai CHUANBO GONGCHENG [SHIP ENGINEERING] in Chinese Feb 96 No 1, pp 40-43, 25

[Article by Liu Sheng [0491 0524], Han Jingmei [7281 0079 2734], and Zhou Yuying [0719 1342 5391] of Harbin Engineering University; no MS receipt date given]

[FBIS Summary] Mine-hunting vessels [equipped with mine-hunting sonar arrays] have been shown by a number of foreign experts over a long period of analysis to be an effective mine-countermeasures method. Dynamic modeling and design of the controller for a servo system for azimuth-angle movement and attitude in a mine-hunting sonar array is carried out in this paper. The designed system is digitally simulated in a computer. It is shown that despite change of system parameters (within permissible ranges), the designed servo system displays satisfactory performance in correcting both pitch and roll.

Six figures, reproduced below, show a block diagram of the servo system principle, a block diagram of the servo system dynamics, a block diagram of the servo system dynamics for azimuth-angle movement and attitude, a plot of the step response, the sine track for T_m = 0.4 s, and the sine track for T_m = 0.2 + | 0.4 sin 0.33 t |, respectively. The one table, reproduced below, lists simulation results.

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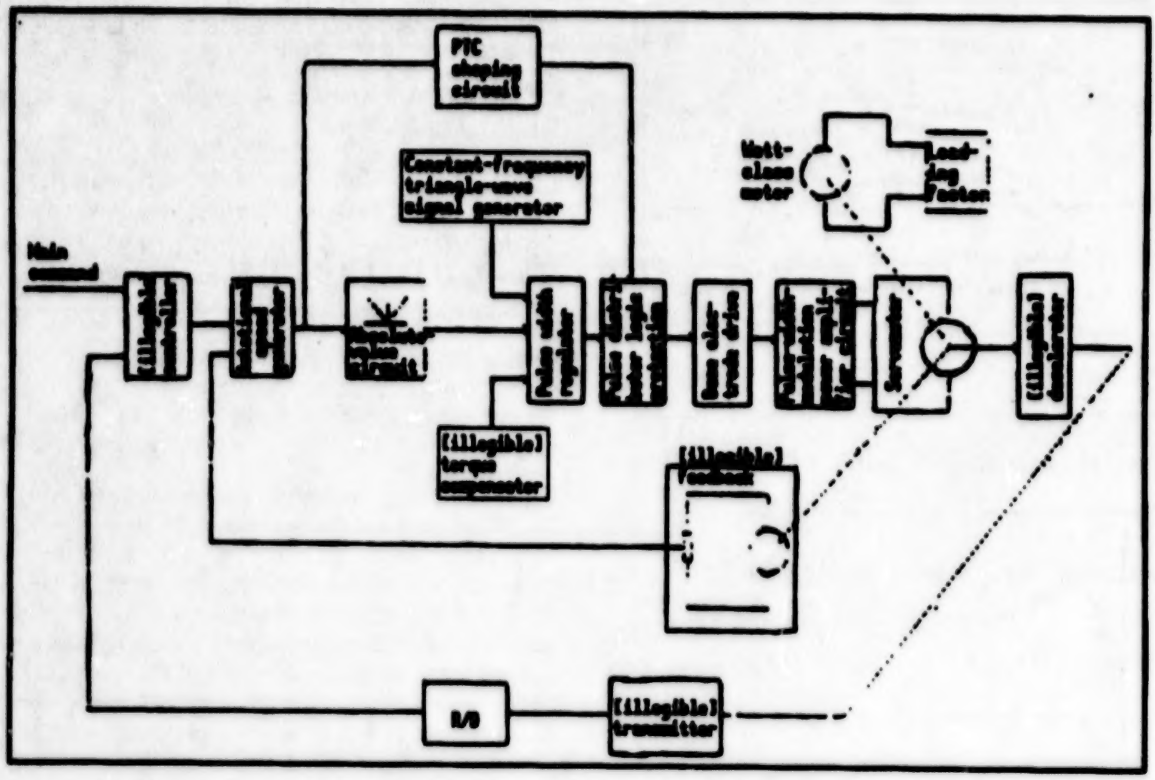

Figure 1. Block Diagram of Servo System Principle

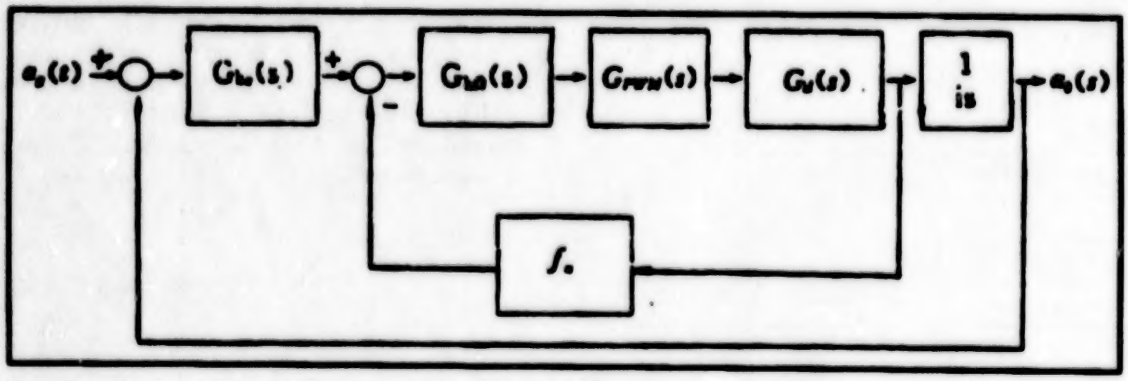

Figure 2. Block Diagram of Servo System Dynamics

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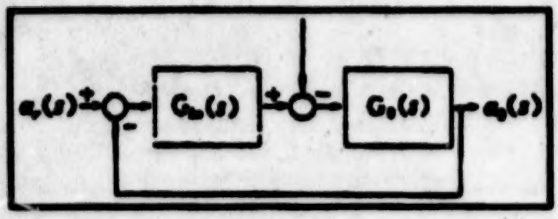

Figure 3. Block Diagram of Servo System Dynamics for Azimuth-Angle Movement and Attitude

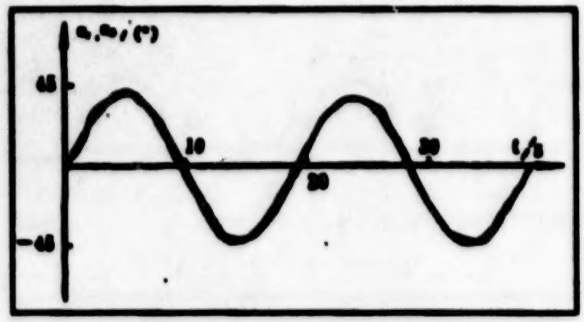

Figure 5. Sine Track for T_m = 0.4 s

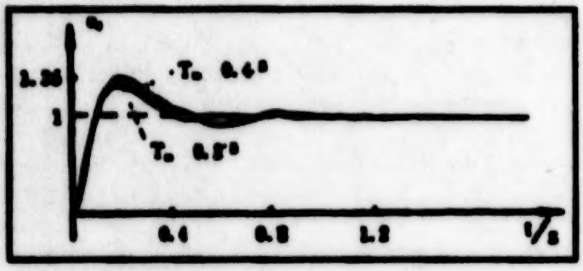

Figure 4. Step Response

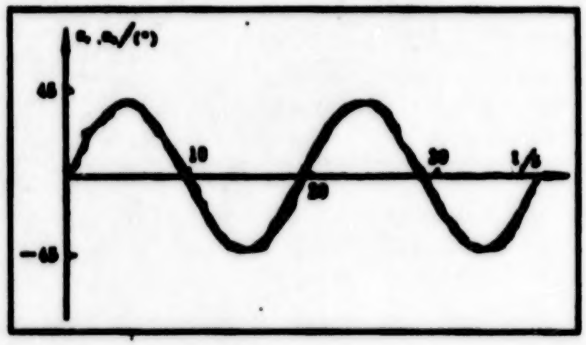

Figure 6. Sine Track for T_m = 0.2 + | 0.4 sin 0.33 t |

Table 1. Statistical Results of Simulation

T_m(s)	$\alpha_r(t) = 1(t)$			$\alpha_r(t) = 45°\sin 0.33t$
	Peak time (s)	Peak value	Regulating time (s)	Maximum error e_m
0.2	0.2	1.30	0.38	2.21'
0.4	0.2	1.35	0.38	2.21'
0.2 + | 0.2 sin 0.33t |	0.2	1.31	0.38	2.20'
0.2 + | 0.4 sin 0.33t |	0.2	1.31	0.38	2.21'

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China: Study of Adaptive Matching of Ocean Sound Channel

96P30171D Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Mar 96
Vol 21 No 2, pp 139-148

[Article by Chen Geng [7115 1649] of the CAS Institute of Acoustics, State Key Laboratory of Acoustics, Beijing 100080; MS received 8 Mar 94]

[FBIS Summary] The objective of ocean acoustic channel matching for passive sonar detection is similar to equalization of an electric-wave communications channel: to correct for the influence of the channel on the transmitted sonar signal weight and to increase equipment performance (higher measurement accuracy for hydroacoustic measuring equipment, greater detection range for passive sonar equipment, lower BER for hydroacoustic communications, and improved data rate). In this paper, based on a study of the time- and space-variant characteristics of ocean sound channels, the channel response function is found by adaptive filtering with a transversal filter. The obtained channel response function is applied to the matching of the channel and satisfactory effects are shown. The key problem is how to increase the convergence speed of the adaptive iteration equation (least-mean-squares algorithm). For this purpose, besides using step-size factor adaptive adjustment and performing frequency-domain adaptive filtering, a rational choice of weight-coefficient parameters (number of weights and time relationship between weights) is proposed to raise the speed of solution for the channel response function.

In an experiment, the author has used channel-transmitted linear FM signals recorded at sea and then fed into the computer for channel matching. The data were obtained from a 1991 Sino-Russian joint exploration of acoustic channel transmission in the Philippine Sea. Transmitting ship and receiving ship were about 150 km apart and ocean depth was about 5000 meters. The transmitting ship's transducer was a directional tow [i.e., towed-line array] pointing toward the remote receiving ship; tow depth was 100 meters and speed was 3 m/s. The receiving hydrophone was allowed to drift out away from the receiving ship and to sink, stopping at about 100 m depth. The transmitting ship sent out linear FM pulses with an initial frequency of 500 Hz, FM of 200 Hz (resolution = 5 ms), pulse width of 10 s, and spacing of 60 s. The unprocessed received signals had a maximum SNR of 6 dB and a minimum of 0 dB or less (see Figure 4 below). Received signals, recorded with a magnetic tape recorder, were put through a parametric amplifier for amplification, using 2-kHz frequency sampling (sampling period of 0.5 ms). After 12-bit quantization, the signals were stored in the computer.

The results of this study demonstrate that when the weight parameters are rationally chosen, a complicated channel response function can be expressed by a few weights. The correlation output is noticeably improved, indicating the effectiveness of this method of channel adaptive matching.

Eight figures, reproduced below, show the copy correlation output for periodically repeated linear FM pulses after channel transmission (eight different cross-correlation coefficients), the pulse correlation output for the periodically repeated linear LM pulses after channel transmission (eight different cross-correlation coefficients), a flow chart for the adaptive filter channel-matching process, typical received waveforms for four different FM signals (FMSs), the results of processing the received signals via the aforementioned channel-matching algorithm for M (number of weights) = 16 and minimum weight spacing $\tau = 5\Delta T$ (where $\Delta T = 0.5$ ms is the sampling period), and the same for a number of different values of M and τ. There are no tables.

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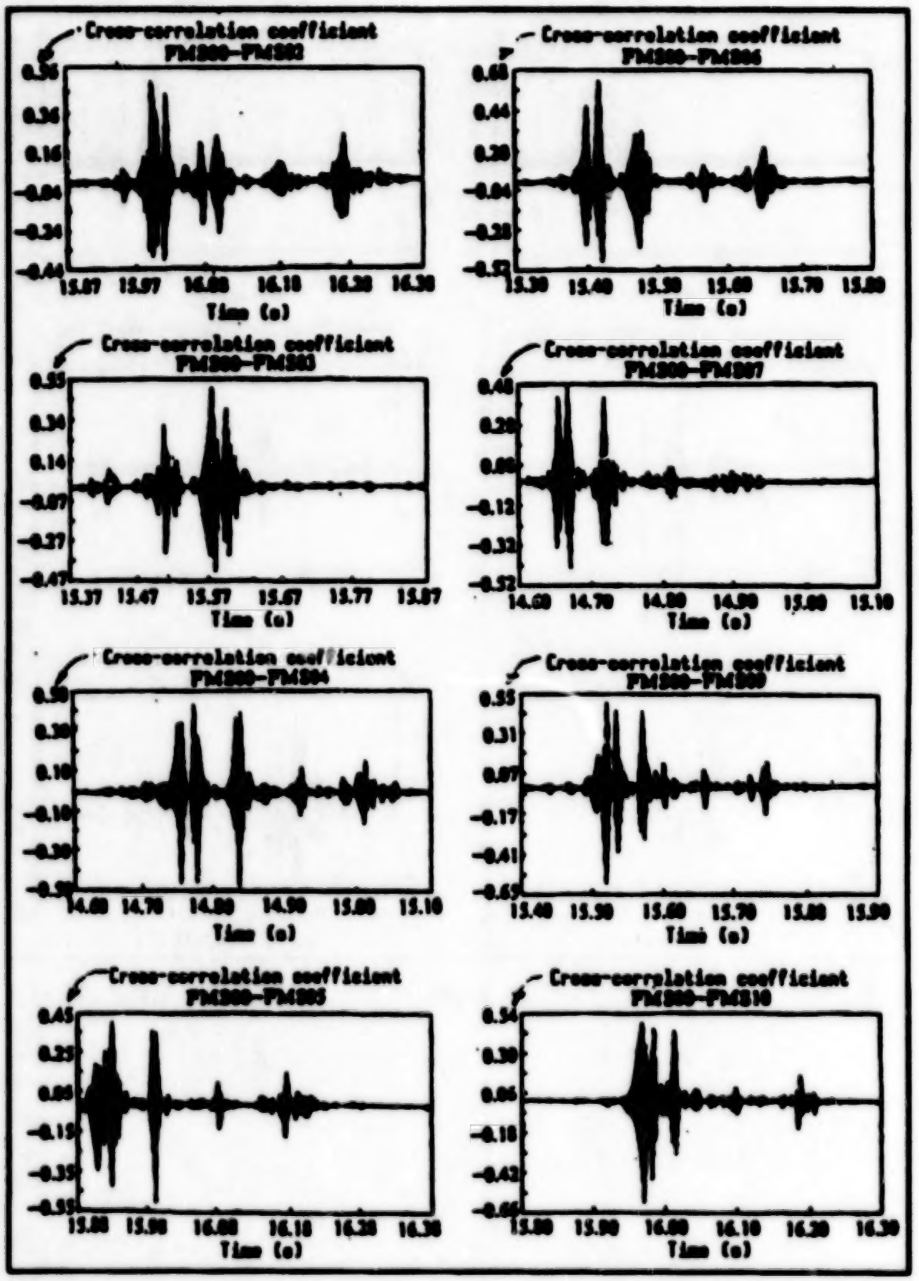

Figure 1. Copy Correlation Output for Periodically Repeated Linear FM Pulses after Channel Transmission; signal time resolution = 5 ms, signal pulse interval = 60 s.

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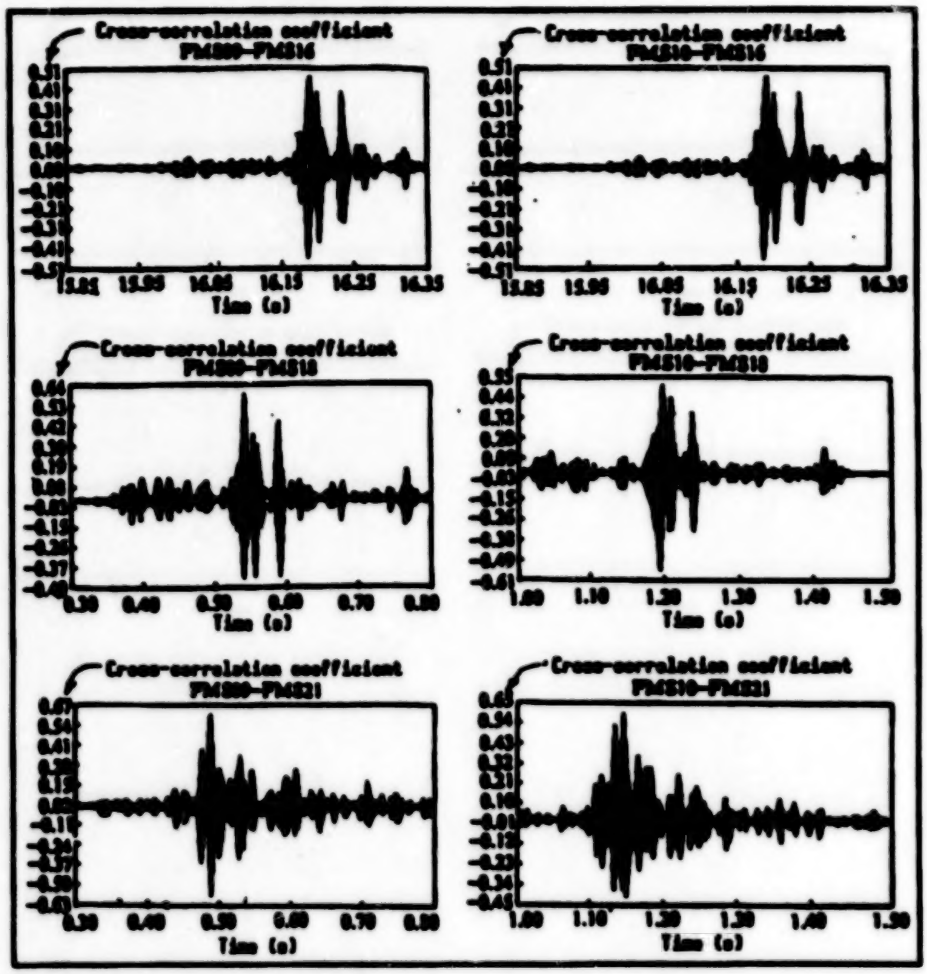

Figure 2. Pulse Correlation Output for Periodically Repeated Linear FM Pulses After Channel Transmission

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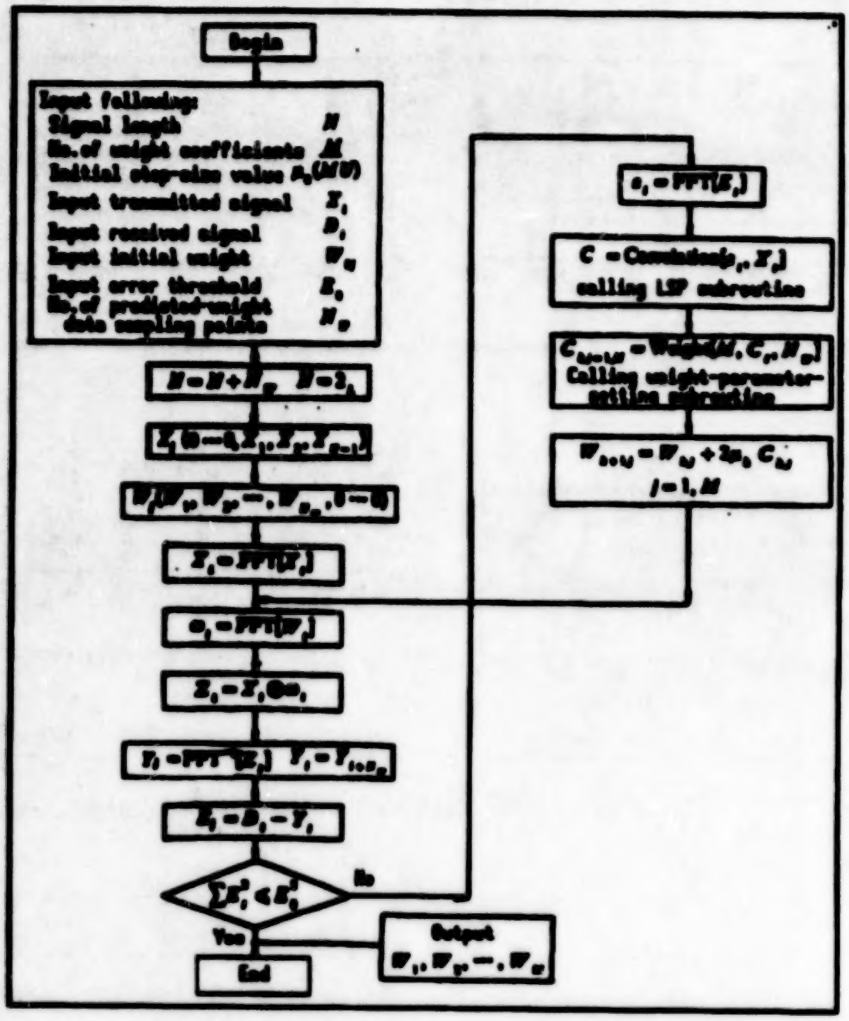

Figure 3. Flow Chart for Adaptive Filter Channel-Matching Process

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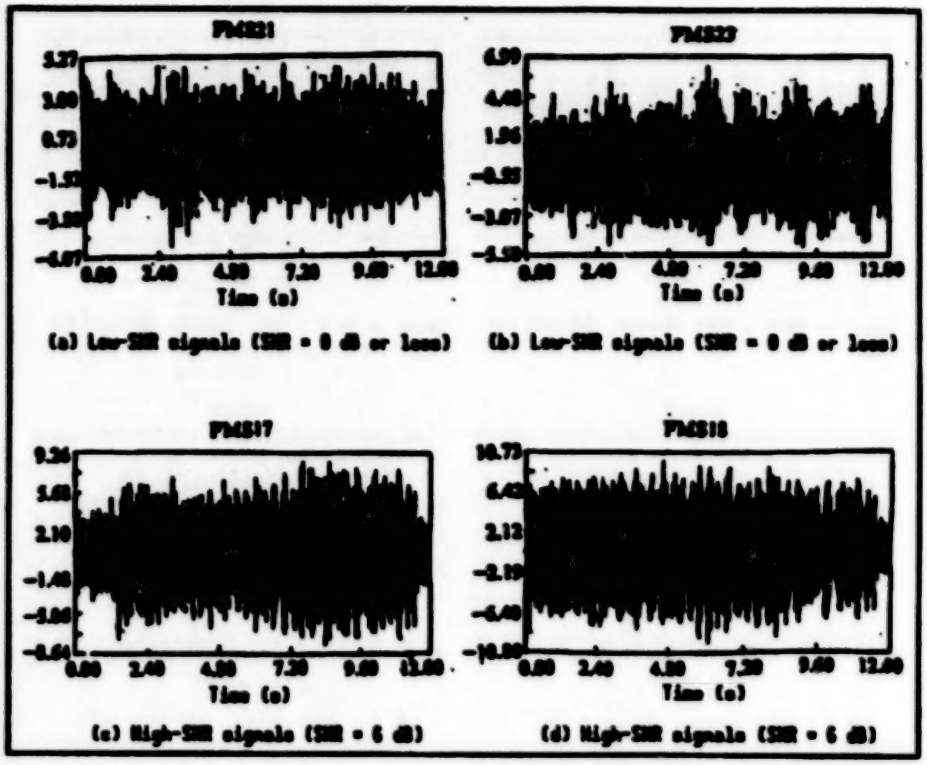

(a) Low-SNR signals (SNR = 0 dB or less) (b) Low-SNR signals (SNR = 0 dB or less)

(c) High-SNR signals (SNR = 6 dB) (d) High-SNR signals (SNR = 6 dB)

Figure 4. Typical Received Signals

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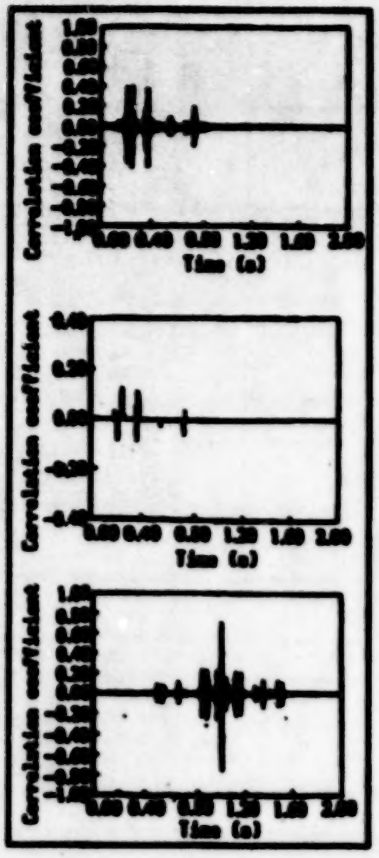

Figure 5(a). Results of Channel-Matching Processing for M = 16, $\tau = 5\ \Delta T$

Top plot is correlation coefficient for the copy correlation processing output before channel matching, middle plot is the channel response function, bottom plot is the correlation coefficient of the correlation processing output after channel matching.

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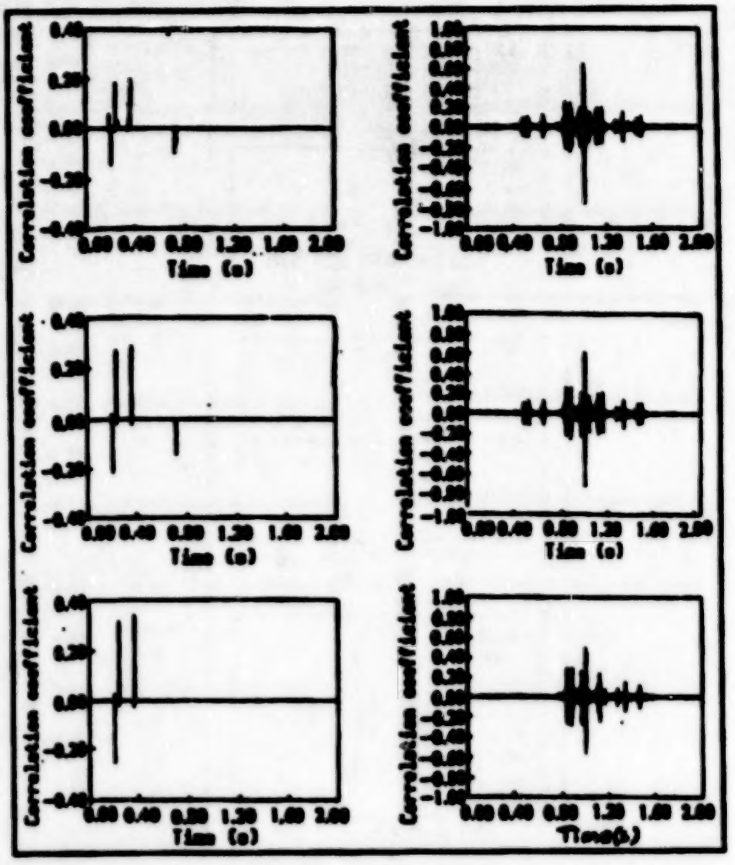

Figure 5(b). Results of Channel-Matching Processing for Different Values of M and τ

Same received signal as in Figure 5(a)); top plot is for M = 8, τ = 10 ΔT; middle plot is for M = 4, τ = 20 ΔT; bottom plot is for M = 3.

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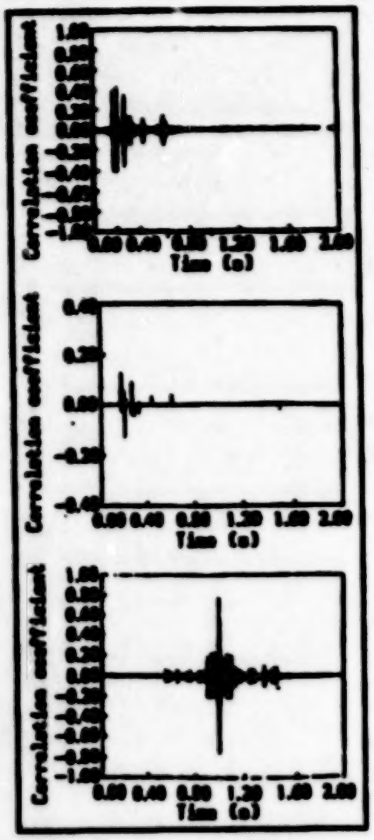

Figure 6. Results of Channel-Matching Processing for M = 12, $\tau = 7\ \Delta T$

Top, middle, and bottom plots same as in Figure 5.

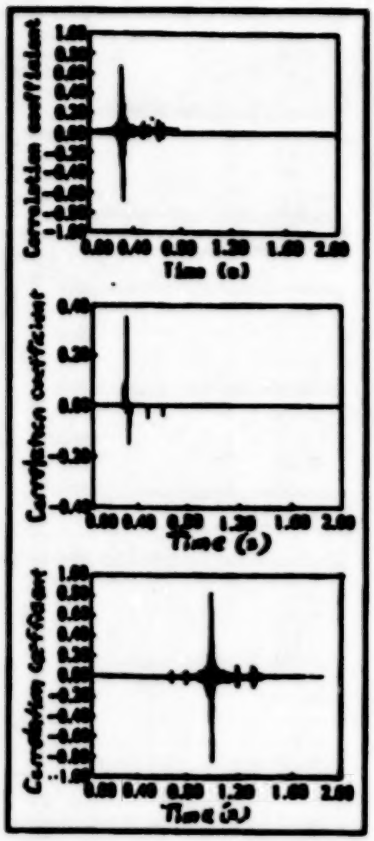

Figure 7. Results of Channel-Matching Processing for M = 8, $\tau = 11\ \Delta T$

Top, middle, and bottom plots same as in Figure 5.

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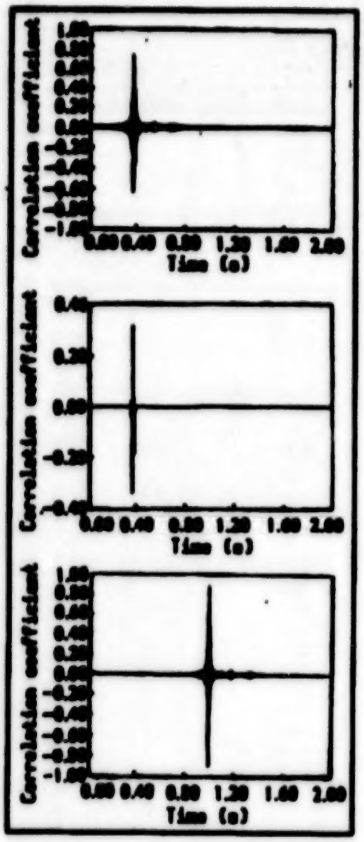

Figure 8. Results of Channel-Matching Processing for M = 4, τ = 8 ΔT

Top, middle, and bottom plots same as in Figure 5.

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China: Pattern Recognition of Acoustic Sea-Bed Profiling Records (Part 2: Fuzzy Logic Reasoning Expert System)

96P30171E Beijing SHENGXUE XUEBAO [ACTA ACUSTICA] in Chinese Mar 96
Vol 21 No 2, pp 149-155

[Article by Zhang Shuying [1728 0647 5391] and Cao Min [2580 3046] of the CAS Shanghai Acoustics Laboratory, Shanghai 200032; MS received 1 Mar 95 (part 1 [same as ref. 1] is published in FBIS-CST-96-006, 30 Apr 96 pp 37-39)]

[FBIS Summary] An expert system based on fuzzy set theory has been developed for a computer-based pattern recognition system for Acoustic Sea-bed Profiling Records (ASPRs). The standard pattern characteristic-state sets appearing in the ASPRs and corresponding to 10 geological categories of marine sediment layers have been defined by experienced specialists, and the weight of each pattern characteristic-state in determining the geological classification has been analyzed in detail and calculated. Through an inquiry into the pattern characteristic-states appearing in the ASPRs under interpretation, followed by calculation of the approximation factors (how much the ASPR entries correspond to the standard ones for the 10 categories of sediment layers), the geological classification of the layers can be determined by selecting the maximum approximation factor.

Three figures, reproduced below, show the operating principle for the ASPR image recognition system, the ASPR for Xiamen Harbor, and the engineering geological cross section for Xiamen Harbor, respectively. The three tables are also reproduced below.

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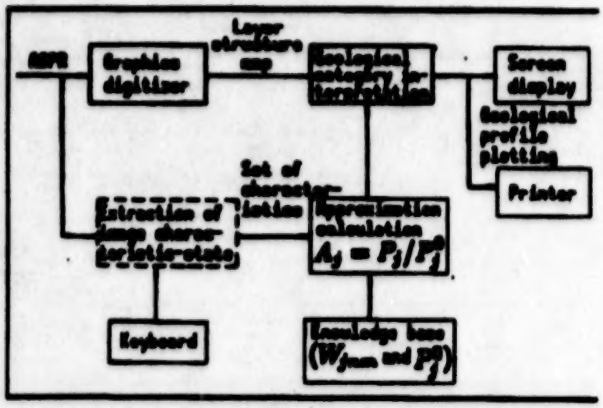

Figure 1. Operating Principle of ASPR Image Recognition System

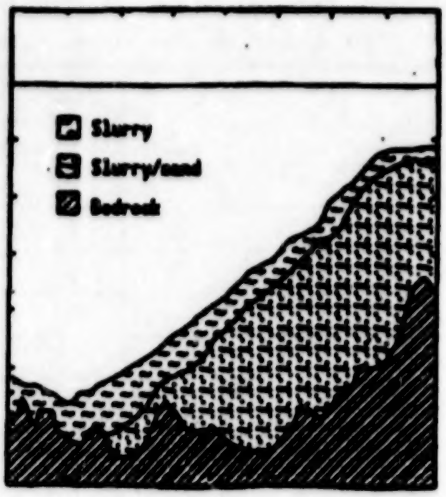

Figure 3. Engineering Geological Cross Section for Xiamen Harbor

Figure 2. ASPR for Xiamen Harbor

Table 1. Pattern Characteristics of ASPRs and Their Manifest States

Image characteristic	Code	State		
		1	2	3
Depth of interlayer color	C_1	Thin	Slightly deep	Deep
Change of interlayer color level	C_2	Not apparent	Relatively slow	Fast
Interlayer scan grains	C_3	Small	Moderate	Relatively large
Smoothness of layer surface lines	C_4	Smooth	Slightly smooth	Not smooth
Fineness of layer surface lines	C_5	Fine	Slightly coarse	Coarse
Fluctuations of layer surface lines	C_6	Small	Slightly large	Large
Condition of layer surface lines	C_7	Discontinuous	Relatively long	Does not exist

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Table 2. Set of Recorded-Image Standard Characteristic-States Corresponding to Different Layer Categories

Layer category	Image characteristic						
	C_1	C_2	C_3	C_4	C_5	C_6	C_7
1. Slurry	C_{11}	C_{21}	C_{31}	C_{41}	C_{51}	C_{61}	C_{73}
2. Slurry mixed with silt	C_{11}	C_{21}	C_{31}	C_{41}	C_{51}	C_{61}	C_{71}
3. Slurry-medium semi-clay	C_{12}	C_{21}	C_{31}	C_{41}	C_{51}	C_{61}	C_{72}
4. Slurry/sand	C_{12}	C_{21}	C_{32}	C_{42}	C_{52}	C_{61}	C_{71}
5. Fine silt	C_{12}	C_{22}	C_{31}	C_{42}	C_{53}	C_{61}	C_{71}
6. Cobbly sand	C_{13}	C_{23}	C_{33}	C_{43}	C_{53}	C_{61}	C_{73}
7. Compact fine silt	C_{13}	C_{22}	C_{32}	C_{42}	C_{51}	C_{61}	C_{73}
8. Semi-sandy soil	C_{13}	C_{22}	C_{32}	C_{42}	C_{53}	C_{62}	C_{73}
9. Clay	C_{13}	C_{22}	C_{32}	C_{42}	C_{53}	C_{62}	C_{71}
10. Bedrock	C_{13}	C_{23}	C_{32}	C_{43}	C_{53}	C_{63}	C_{73}

Note: In the table, C_{12} indicates that the manifest state of image characteristic C_1 is 2, others likewise.

Table 3. Table of Numerical Values of Weight Coefficient W_{jnm}

Layer category (j)	State (m)	Characteristic (n)							
		C_1	C_2	C_3	C_4	C_5	C_6	C_7	P_j^0
1. Slurry	1	3/9	3/16	3/17	3/14	3/13	3/23	0	1.4728
	2	1/16	1/18	1/20	1/20	1/12	1/14	0	
	3	0	0	0	0	0	0	1/15	
2. Slurry mixed with silt	1	3/9	3/16	3/17	3/14	3/13	3/23	1/4	1.5228
	2	1/16	1/18	1/20	1/20	1/12	1/14	0	
	3	0	0	0	0	0	0	0	
3. Slurry-medium semi-clay	1	1/9	3/16	3/17	3/14	3/13	3/23	0	2.1270
	2	3/16	1/18	1/20	1/20	1/12	1/14	1	
	3	1/18	0	0	0	0	0	0	
4. Slurry/sand	1	1/9	3/16	1/17	1/14	1/13	3/23	1/4	1.3054
	2	3/16	1/18	3/20	3/20	3/12	1/14	0	
	3	1/18	0	0	1/11	1/16	0	0	
5. Fine silt	1	1/9	1/16	3/17	1/14	0	3/23	1/4	1.2486
	2	3/16	1/18	1/20	3/20	1/12	1/14	0	
	3	1/18	1/10	1/8	1/11	3/16	0	0	

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Layer category (j)	State (m)	Characteristic (n)							
		C_1	C_2	C_3	C_4	C_5	C_6	C_7	P_j^0
6. Cobbly sand	1	0	0	0	0	0	3/23	0	1.6323
	2	1/16	1/18	1/20	1/20	1/12	1/14	0	
	3	3/18	3/10	3/8	3/11	3/16	0	1/5	
7. Compact fine silt	1	0	1/16	1/17	1/14	3/13	3/23	0	1.1945
	2	1/16	3/18	3/20	3/20	1/12	1/14	0	
	3	3/18	1/10	1/8	1/11	3/16	1/5	1/5	
8. Semi-sandy soil	1	0	1/16	1/17	1/14	0	1/23	0	1.2351
	2	1/16	3/18	3/20	3/20	1/12	3/14	0	
	3	3/18	1/10	1/8	1/11	3/16	1/5	1/5	
9. Clay	1	0	1/16	1/17	1/14	0	1/23	1/4	1.2851
	2	1/16	3/18	3/20	3/20	1/12	3/14	0	
	3	3/18	1/10	1/8	1/11	3/16	1/5	0	
10. Bedrock	1	0	0	1/17	0	0	0	0	1.8769
	2	1/16	1/18	3/20	1/20	1/12	1/14	0	
	3	3/18	3/10	1/8	3/11	3/16	3/5	1/5	

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China: Theory of Wavelet Analysis, Prospect of Its Application in Torpedo Homing Systems

96P30191A Wuhan HAIJUN GONGCHENG XUEYUAN XUEBAO [JOURNAL OF THE NAVAL ACADEMY OF ENGINEERING] in Chinese Mar 96 No 1, pp 14-21

[Article by Zhang Jingyuan and Jiang Xingzhou of the Naval Ordance Engineering Dept.; MS received 12 Dec 95]

[FBIS Summary] The theory of wavelet analysis has become increasingly popular over the past few years in a variety of scientific fields involved with signal and image processing. The U.S. DoD's Critical Technologies Plan states that wavelet analysis has exerted a profound influence on the signal/image processing in the coming key defense technologies. Britain's Royal Academy of Mathematics has listed wavelet analysis as one of the 10 key developments of the 1990s. Other nations likewise have shown scientific research interest in this field. In this paper, the authors briefly review the development history of wavelet analysis, introduce the basic principles of wavelet analysis, and present fast algorithms for wavelet transforms (including the short-time Fourier transform or STFT, continuous wavelet transform or CWT, the discrete wavelet transform or DWT, and the fast wavelet transform or "Mallat algorithm"). Finally, they discuss several potential signal-processing applications of wavelet theory—especially precision guidance and target recognition—in modern torpedo homing systems.

There are no figures or tables.

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China: H/HJQW-1 Submarine Log Described

96P30191B Wuhan HAIJUN GONGCHENG XUEYUAN XUEBAO [JOURNAL OF THE NAVAL ACADEMY OF ENGINEERING] in Chinese Mar 96 No 1, pp 95-98

[Article by Gao Qixiao, Li An, Zhang Chongwei, Gao Jindong, and Hu Baiqing of the Ship Electrical Engineering Dept. and Zhang Weimin of the Qingdao Base Navigation Safety and Maintenance Plant; MS received 6 Oct 95]

[FBIS Summary] The shortcomings of the mercury hydrodynamic log are pointed out and the composition, operating principle, and main characteristics of a new smart-sensor-based submarine microcomputerized log, model H/HJQW-1, are described. This new log, developed by the authors, incorporates advanced microprocessor technology, very large-scale ICs (VLSI), and a digitized angle transmission unit. The log consists of a conduit-line coupling adapter, made up in turn of three on-off valves and two gas-release valves; a microprocessorized, "smart," capacitive resonance programmable pressure sensor; and the main instrument, an MCS-51 monolithic computer-based special microcomputer system, consisting in turn of a DC power supply, CPU, EPROM, EEPROM, the digital transmission and interface circuits, the ship-speed information transmission unit, the input keyboard, and a display. The ship-speed information transmission unit, in turn, consists of a solid-state angle coder and servo circuits.

A year's field testing of this new log aboard an in-service submarine has indicated the following results: (1) the smart pressure sensor, which is smaller and longer-lived than the sensor in the original log, is resistant to marine biological pollution, easier to replace and maintain, and much higher in velocimetric accuracy (repeat measurement accuracy was better than 0.8 kN after 9 months of use); (2) the software design incorporates a number of reliable techniques for log error correction and resistance to jamming; (3) the entire unit has reliable self-diagnostic functions and its computerized and automated characteristics make it quite user-friendly.

This new log is much lower in weight and volume (about 1/10th for each) compared to the older log, very much lower in power consumption (about 1/30th as much), and lower in noise.

Two figures, not reproduced, show a block diagram of the new log and a block diagram of the main instrument, respectively. There are no tables or references.

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China: Model GPT-1 GPS Position Finder/Timer Described

96P30183A Beijing HANGTIAN JISHU YU MINPIN [ASTRONAUTICS TECHNOLOGY AND CIVIL PRODUCTS] in Chinese Jan 96 No 1, p 21

[Article by reporter Yao Shuyi]

[FBIS Summary] The model GPT-1 GPS [satellite Global Positioning System] position finder/timer, developed by Institute 513 engineers using imported OEM [original equipment manufacturer] parts, has been successfully incorporated into and forms a key part of a priority state satellite applications R&D project entitled "Research on a Satellite Communications Network GPS Time-Frequency Synchronous System." This system has numerous applications in geodesy, navigation, velocimetric/direction-finding equipment, and other radio electronic-measurement engineering fields. Vehicle, ship, and aircraft testing have shown that the system's performance is stable and reliable, meeting all design requirements.

Main technical specifications for this system are as follows:

- receiving freq = 1575.42 MHz
- # of simultaneously trackable satellites = 8
- for both IPPS pulse (second pulse) and IPPM pulse (minute pulse): timing accuracy < 1 μs (RMS), leading-edge rise time < 300 ns TTL level, output impedance = 50 ohms
- capture time = 2 s - 2 min
- antenna receiving sensitivity = -166 dBW, 50-ohm impedance, 9-m feed line length
- panel displays: year, month, day, hour, minute, second, latitude, longtitude, velocity, bearing, magnetic declination, etc.
- time-code output values: code type is ASCII or BCD [binary coded decimal], mode is serial RS232 standard
- GPS navigation electronic-text output values: code type is ASCII, mode is serial 232 standard; can be put on line with a computer for navigation position finding and data display
- position-finding accuracy is 3-10 m (RMS) for differential positioning (DGPS) and 15 m (RMS) for non-differential positioning (with SA [selective availability], 100 m)
- velocimetric accuracy = 0.2 m/s (RMS)
- dynamic characteristics: speed, 999 knots; acceleration, 3g; acceleration rate, 20 m/s^3
- power supply: DC 6-16 V (adapter for AC power supply or battery), power dissipation = 1.2 W
- dimensions: 150 mm x 120 mm x 40 mm
- weight: 0.6 kg

China: HTS IR Detector-Based Prototype Thermal Imager Tested

96P30179A Hefei DIWEN YU CHAODAO [CRYOGENICS AND SUPERCONDUCTIVITY] in Chinese Feb 96 Vol 24 No 1, pp 22-25

[Article by Ju Jing [7263 7234], Zhou Fangqiao [0719 2455 2890], Xiong Jian [3574 0256], and Jiang Hong [5592 3163] of Huazhong (Central China) Univ. of Science & Technology (HUST), Wuhan 430074; MS received 25 Sep 95]

[FBIS Summary] An 8-element, linear-array, YBCO [yttrium-barium-copper oxide] high-temperature superconducting infrared (HTS IR) detector-based prototype thermal imager developed by HUST is described. Test results of this prototype in the 8-14-micron IR band are provided, the detection feasibility of HTS detectors at long-wave IR bands is proven, and some experimental thermal images have been obtained.

The HTS IR detector consists of eight 100-micron x 40-micron microbridges as the light-sensitive elements. Average detectivity D[bar]* is 3 x $10^9 cmHz^{1/2}W^{-1}$, average noise equivalent power NEP[bar] is $10^{-13}VW^{-1}Hz^{1/2}$, and the on-screen display size is 64 x 8 pixels.

Other optical-system design parameters are as follows:

- average transmissivity is over 96 percent
- lens through-light aperture D_0 = 50 mm
- focal length f = 60 mm
- static angular separation between the mirror normal and the lens optical axis is 45°
- maximum rotation angle of the planar mirror is 11.52°
- planar lens size is 50 mm x 79.1 mm
- operating current for the constant-current bias circuit is tunable in the 0.5-12 mA range
- 3-stage overall amplification factor for the preamp and intermediate-frequency (IF) amp circuits is 2000
- IF gain is 100
- cutoff frequency f = 5 Hz
- signal sampling is accomplished via an SY-08 8-bit AD/DA data-conversion card
- output signal for the prototype is achieved with a programmable 6-bit I/0 interface card with two 8255A parallel interface chips
- prototype software is written in C

Prototype testing indicates the following performance parameters:

- center spacing of the light-sensitive elements is 100 microns

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- overall length of the 8-element detector is 740 microns
- step angular spacing is 0.09°C
- transient FOV alpha = 1.667 mrad
- transient FOV beta = 0.667 mrad
- overall FOV A = 200.96 mrad
- overall FOV B = 12.33 mrad
- frame speed F = 18.75 frames/s
- scanning efficiency eta = 0.4 (H value), 0.43 (v value), or 0.172 (sc value)
- residence time tau_d = 3.29 x 10^{-5} second
- system equivalent noise bandwidth delta F = 23.86 kHz
- noise equivalent thermal difference NETD = 0.99 K

Four figures, not reproduced, show the R-T [resistance vs temperature] and dR/dT-T [differential resistance/differential temperature vs temperature] curves for the superconductor, a schematic of the operating principle for the prototype thermal imager, a schematic of the D/A conversion function, and a schematic of the computer program module for the prototype. There are no tables.

References: 1 English, 4 Chinese.

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Taiwan: NSC Signs Memorandum of Cooperation With German Institute for MEMS Research

96P30178A Taipei K'OHSUEH FACHAN YUEK'AN [NATIONAL SCIENCE COUNCIL MONTHLY] in Chinese Jan 96 Vol 24 No 1, pp 54-55

[FBIS Summary] To foster technical exchange and cooperation between ROC scientists and German researchers in the field of microelectromechanical systems (MEMS), the National Science Council has signed a Memorandum of Cooperation (MOC) with Germany's Forschungszentrum Karlsruhe. This agreement will provide ROC scientists in this field with opportunities for training and cooperative research with their German colleagues and will provide a boost to the development of a ROC MEMS industry in the Tainan Science and Industry Park. Forschungszentrum Karlsruhe, a German Federal Ministry of Science and Technology-supported research institute, is a specialist in the LIGA [Lithographie, Galvanoformung, und Abformung (lithography, electroplating, and plastic molding)] technique for fabrication of MEMS systems. According to the MOC, both parties agree to cooperate in MEMS technology, especially in the development of the MEMS technique; in management of MEMS R&D; in technical resources and data; and in personnel training.

China: Two-Dimensional Quantum Well Wire Semiconductor Laser Arrays

40100052A Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Feb 96 Vol 17 No 2, pp 155-160

[Article by Qian Yi, Zhang Jinming, Xu Zuntu, Chen Lianghui, and Wang Qiming of the National Integrated Optoelectronics Laboratory, Institute of Semiconductors, CAS, Beijing 100083, and Zheng Lianxi and Hu Xiongwei of the National Research Center for Optoelectronics Technology, P.O. Box 912, Beijing 100083; supported by the National Natural Science Foundation of China; MS received 8 Sep 94, revised 17 Jan 95]

[FBIS Transcribed Text] **Abstract:** We have fabricated two-dimensional GaAs/AlGaAs quantum well wire (2D-QWW) semiconductor laser arrays by metallorganic chemical vapor deposition on nonplanar substrates and performed surface-emitting electroluminescence to study their subband structures. Using an appropriately high Al mole fraction (40%) and low growth temperature, we have achieved minimum subband separation as large as 27 meV, which is almost equal to thermal energy at room temperature. Even though the effective width of QWWs is extremely small (up to 6 nm), the linear light output power of the laser arrays has still reached over 100 mW under pulsed conditions (1 μs pulses at 1 kHz) at room temperature. This is mainly due to the adoption of 2D laser array structures in QWW device design.

Two dimensional (2D) quantum confinement and small active volume in quantum well wire (QWW) semiconductor lasers are expected to result in improved performance compared to conventional quantum well (QW) lasers.[1,2] Among many approaches to fabricate QWW lasers by metal-organic chemical vapor deposition (MOCVD) on nonplanar substrates has more potential for this purpose due to formation of defect-free interfaces entirely during the epitaxial growth process.[3] With this approach, some expectations are verified including enhanced optical gain [4,5] and reduced threshold current.[6,7] However, large QWW subband separation greater than thermal energy k_BT (up to 25 meV) at room temperature is still desirable and should be achieved by reducing the wire size.[8] The small active volume, however, is disadvantageous in realizing powerful light output of QWW lasers for some practical applications. To circumvent it, it is helpful to adopt a structure with QWW lasers line-arranged parallel as well as perpendicular to the direction of epitaxial growth, which we call 2D-QWW laser array structure.

In this paper, we report on GaAs/AlGaAs 2D-QWW laser arrays grown by MOCVD on nonplanar substrates at 700°C. Surface-emitting electroluminescence spectra indicate the subband separation as large as 27 meV, which is almost equal to the thermal energy at room temperature. The effective width of QWWs is estimated to be about 6 nm, while, the linear light output power of the laser arrays has reached over 100 mW under pulsed conditions (1 μs pulses at 1 kHz) at room temperature. To our knowledge, the above light output power is the highest value reported to date for all kinds of QWW lasers, and the subband separation is the largest reported to date for the GaAs/AlGaAs QWWs incorporated in laser structures.

The (100) n^+-GaAs substrate was patterned into a sawtooth-shaped grating oriented along [011[bar]] direction using conventional photolithography and wet chemical etching techniques.[9] The sawtooth-shaped grating with a period of 6 μm included sets of V-grooves separated by mesas. The grooves were up to 2.5 μm deep and up to 4.5 μm wide. A multiple quantum well (MQW) graded-index (GRIN) separate confinement heterojunction laser structure was grown on the patterned substrate in a horizontal, low pressure MOCVD reactor, as previously described in more detail.[10] The grown layer sequence consisted of 200 nm n-GaAs buffer layer (Se doped, $5 \times 10^{17}cm^{-3} < n < 10^{18}cm^{-3}$), 3 μm n-$Al_{0.6}Ga_{0.4}As$ lower cladding layer (Se doped, $n = 2\text{-}5 \times 10^{17}cm^{-3}$), 110 nm undoped GRIN

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$Al_xGa_{1-x}As$ (x linearly graded from 0.6 to 0.4), four 5 nm GaAs QWs separated by five 26 nm $Al_{0.4}Ga_{0.6}As$ barriers, 110 nm undoped GRIN $AlxGa_{1-x}As$ (x from 0.5 to 0.6), 1 μm p-$Al_{0.6}Ga_{0.4}As$ upper cladding layer (Zn doped, p = 7 x $10^{17}cm^{-3}$), and 200 nm p^+-GaAs cap layer (Zn doped, $p = 10^{19}cm^{-3}$). All thicknesses correspond to the growth rates on a planar substrate. All layers were grown at 700°C except for the p-GaAs cap layer grown at 650°C. Au-Zn-Au and Au-Ge-Ni were used for the p- and n-side metallizations, respectively. Proton implantation (120 keV energy, 3 x $10^{15}cm^{-3}$ dose) was employed to define up to 1 μm-wide conductive stripes above the centers of the bottoms of the V-grooves in order to provide current confinement.

Figure 1 (see last page) shows (011[bar]) cross-sections of the 2D-QWW laser arrays. At the bottoms of the V-grooves, crescent-shaped QWWs are produced due to the combined effects of groove sharpening during the AlGaAs growth and migration of the Ga species to the bottoms of the grooves.[7] As indicated in Figure 1(b) and (c), each of the four crescent-shaped QWWs is 7 nm thick at the centers and up to 60 nm wide total, and the GaAs QW layers are 1.8 nm thick on the side walls of (111) and 8 nm thick on the tops of the mesas. The effective widths of these wires, however, are considerably smaller due to the lateral tapering in the thickness of each crescent. This lateral tapering gives a rise to the lateral potential well that leads to 2D quantum confinement in the QWWs.[3] In addition, resharpening of the V-grooves during the growth of $Al_{0.4}Ga_{0.6}As$ barriers formed four wires with similar cross-sections, which is important for minimizing inhomogeneous gain-broadening effects due to wire size variation. Furthermore, the GRIN waveguide layers are also tapered and thus form a 2D optical waveguide surrounding the QWWS, which is particularly important for maximizing the model gain provided by these lasers with the extremely narrow wires.[8]

Figure 2 shows a light output versus injection current characteristic of a typical 2D-QWW laser array operated at room temperature under the pulsed conditions (1 μs pulses at 1 kHz). The cavity length of the lasers is 200 μm, the width of the chip is 120 μm, and the laser mirrors are uncoated. The threshold curve is 0.7 A for this array consisting of 19 QWW lasers, and the linear pulse light output reaches up to 115 mW at 3.0 A injection current. The light output should be more powerful if the current sources could afford bigger currents in our experiments. The near-field patterns of the laser array shown in the inset of Figure 2 are 19 uniform circular spot arrays centered about the QWW regions. This indicates that our 2D-QWW laser arrays have a good uniformity along the directions not only parallel but also perpendicular to that of the epitaxial growth, and the laser arrays are operated in the fundamental spatial mode.

Figure 3 shows the lasing spectra of the 2D-QWW laser array at room temperature under the pulse conditions. The lasing wavelength is centered at 758.0 nm. The spectra feature multiple longitudinal mode structures. The half-width is 1.2 nm at 1.0 A and enlarged to 2.5 nm at 3.0 A. Furthermore, the center wavelength gradually shifts to longer position above 2.0 A due to thermal effect, which is consistent with the "kink" of the line within the region from 1.4 to 1.6 A in Figure 2.

The surface-emitting electroluminescence measurements were performed at 10 K. Different from the above fabrication process, on the p-side of a chip with 200 μm width and 300 μm length (the cavity length of the lasers), a 50 μm x 50 μm window was opened while the Au-Zn-Au metallization layer within it was etched out. The chip was not processed with the proton implantation, and thus, the uncoated laser arrays consisted of both the QWW lasers at the bottoms of the V-grooves and the QW lasers on the tops of the mesas. They have been operated CW at 10 K with threshold current of 4 mA, and the electroluminescence was detected from the window.

As shown in Figure 4, the structure (A), (B) and (C) are attributed to the QWs on the tops of the mesas (Top QWs), the QWs on the (111) sidewalls (Sidewall QWs), and the QWWs at the bottoms of the V-grooves, respectively. Compared to A and C, the relative intensity of peak B decreases with the increase of injection current because of the efficient carrier capture from the Sidewall QWs into the Top QWs and QWWs.[11] In addition, the wavelength positions of peak A (780.0 nm) and B (679.0 nm) in Figure 4 are in agreement with the calculation results corresponding to 1.8 nm GaAs Sidewall QWs and 8 nm GaAs Top QWs, respectively, using Kronig-Penning model.[9]

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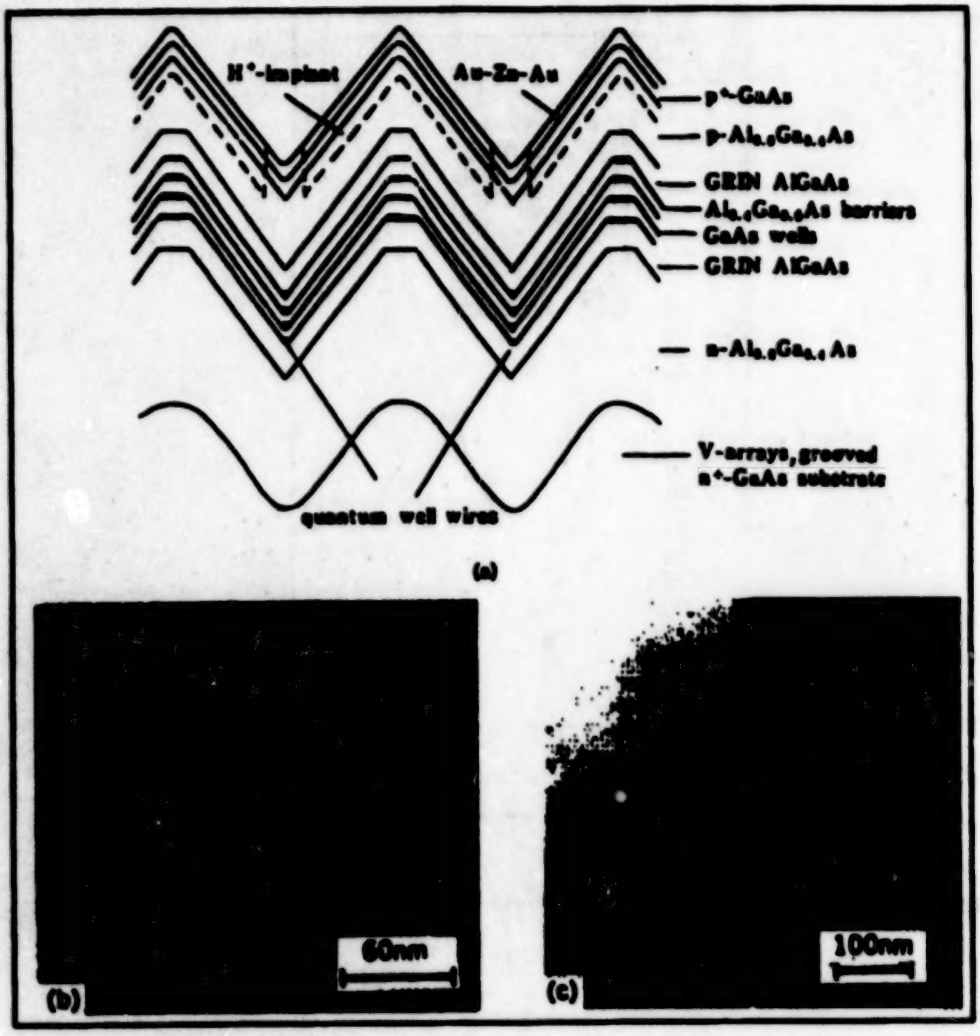

Figure 1. (011[bar]) Cross-Section of 2D-QWW Laser Arrays

(a) Schematic illustration; (b) Bright-field transmission electron micrograph (TEM) of four crescent-shaped QWWs at the bottoms of the V-grooves, where the bright stripe represents GaAs layers and the dark areas AlGaAs; (c) dark-field TEM of QWs on the tops of the mesas, where the dark stripes represent GaAs layers and the bright ones $Al_{0.4}Ga_{0.6}As$ layers

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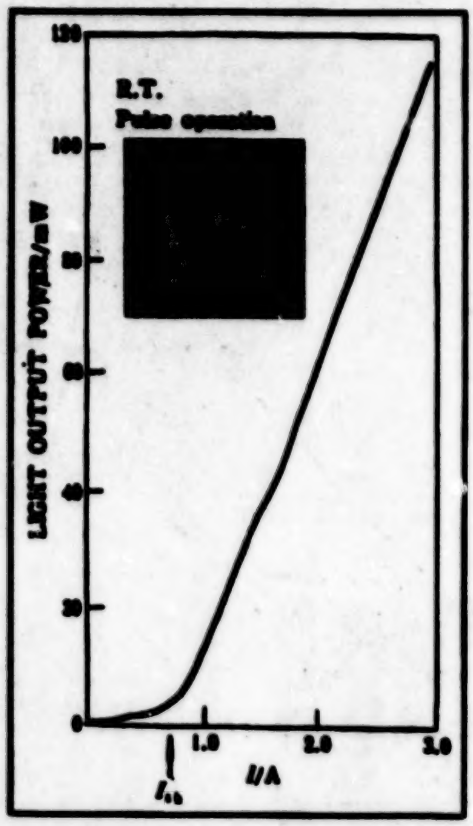

Figure 2. Light Output Vs Injection Current Characteristic of a 2D-QWW Laser Array

The inset shows a photograph of the near-field pattern when I = 2.5 A.

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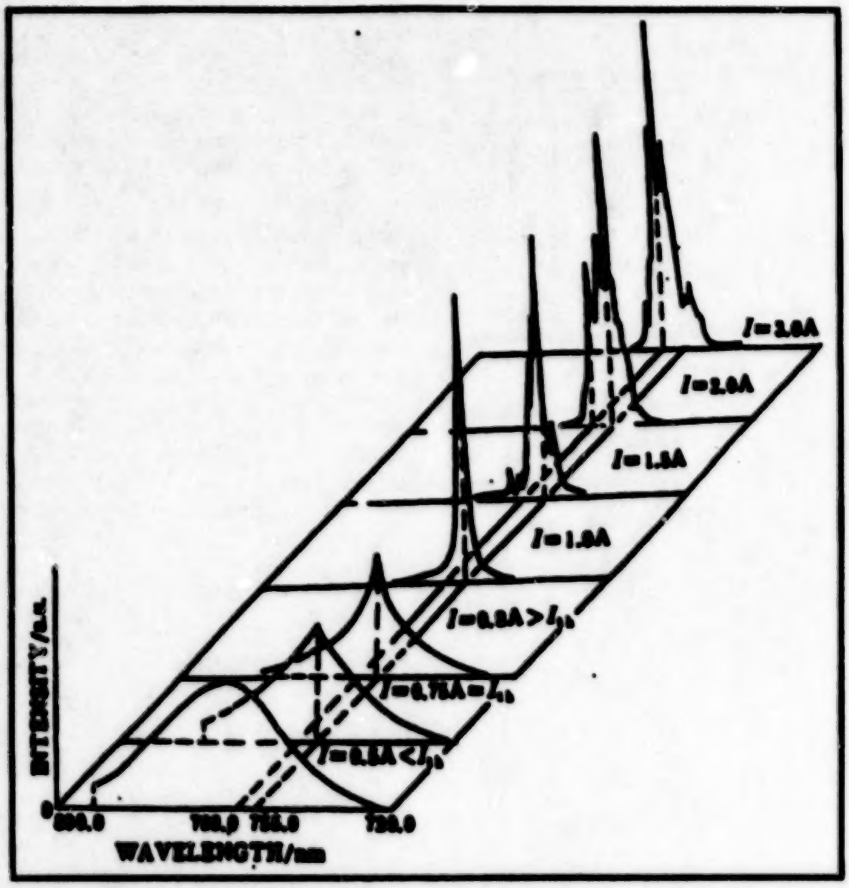

Figure 3. Room Temperature Spectra of the 2D-QWW Laser Arrays at Various Injection Currents

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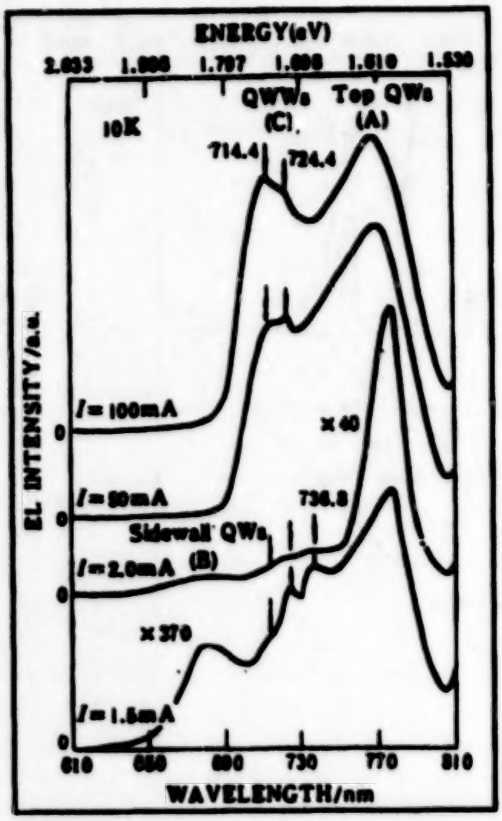

Figure 4. Surface-Emitting Electroluminescence Spectra of the Uncoated Laser Array Operated CW (I_b = 4 mA) at Various Injection Currents at 10 K

The three lowest subbands (l = 0, 1, 2) of the QWWs observed in Figure 4 are at 736.8 nm, 724.4 nm, 714.4 nm at 10 K, respectively, which correspond to 780.8 nm, 768.7 nm and 755.7 nm at room temperature, respectively. Therefore, the 2D-QWW laser arrays were still operated at the high-order (l = 2) subband at room temperature deduced from Figures 3 and 4. However, the separation between the minimum subbands has reached up to 27 meV, which is almost equal to the thermal energy at room temperature.

The lowest subband (l = 0) at 780.0 nm corresponds to energy 1.588 eV. As we have mentioned above, the center of the GaAs crescents is 7 nm thick, which corresponds to the calculated QW lowest subband of 1.504 eV. Thus, there exists an 84 meV blue shift of the lowest subband position of the QWWs compared to that of 7 nm GaAs QWs at the centers of the crescents. This blue shift results from the lateral potential well at the crescents and confirms the formation of QWWs there. Using the model previously described, the effective width of the QWWs is estimated to be about 6 nm.

Further improvements would be expected in the QWW laser performance. Figure 2 shows the output power efficiency is less than 0.1 W/A, which is too low for practical application. This is partly due to the current leakage and the nonuniformity of injection current distribution on the nonplanar substrates. In addition, the device structure needs further optimization.

In conclusion, we have fabricated GaAs/AlGaAs 2D-QWW laser arrays by MOCVD on nonplanar substrates and performed surface-emitting electroluminescence to study their subband structures. Using an appropriately high Al mole fraction (40%) and low growth temperature (700°C), we have achieved minimum subband separation as large as 27 meV, which is almost equal to the thermal energy at room temperature. Even though the effective width of the QWWs is extremely small (up to 6 nm), the linear light output power of the laser arrays has still reached over 100 mW under pulsed conditions at room temperature. It is mainly due to adopting the 2D laser array structures in QWW device design. These efforts would be helpful for realizing powerful QWW lasers for some practical applications.

We wish to thank Professor Junying Xu, Professor Jianwei Xiao, Professor Tiwen Fan, Ms. Wanhua Zheng, Ms. Hui Lu, and Ms. Fangjie Zhuang for their help in this work.

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Overview of China's PT Mobile Communications Networks

40100053A Hong Kong ZHONGGUO WUXIAN TONGXIN [CHINA WIRELESS COMMUNICATIONS] in English Dec 95 No 1, pp 8-9, 12-14

[Article by Su Jinsheng, director, Mobile Communications Bureau, MPT]

[FBIS Transcribed Text] Since its emergence out of various telecoms services some years ago in China, mobile communications has become a new area of telecoms in the country. The "omni-present" mobile communications technology has enabled communications to get rid of the restriction of space, giving people more freedom to communicate. As China's national economy expands and socialist market economy develops further, the demand for faster transmission of information by all sectors of society has been increasingly growing. Providing more convenient service by utilizing the advantages of mobile technology is our departure point for the construction of PTT-operated public mobile communications networks and also the internal momentum of their fast growth. In recent years, under the MPT's guideline of "Development—our priority tasks; reform—the driving force; service—our purpose," China's mobile communications has registered successively rapid expansion.

I. Overview of the Present Situation

Since September 1987, when Guangdong Province cut over the country's first cellular mobile telephone system, the number of mobile subscribers nationwide has averaged a nearly 3-fold annual growth rate. From January to August 1995, China's PTT released 1,239,000 available mobile phone numbers, up 145.6 percent over the same period of the previous year, bringing the total number of mobile subscribers to 2,804,400 as of the end of last August. It is expected that nearly 800,000 additional available numbers will be released from September to end-1995, bringing the total number of mobile subscribers to 3.5 million. (Figure 1: The Growth of the Number of Mobile Phone Subscribers in China)

As of 31 August 1995 (Unit: 10,000)

No.	Year	Mobile phone subscribers
1	1987	0.07
2	1988	0.32
3	1989	0.98
4	1990	1.93
5	1991	4.75
6	1992	17.7
7	1993	63.8
8	1994	156.566
9	1995	280.4403

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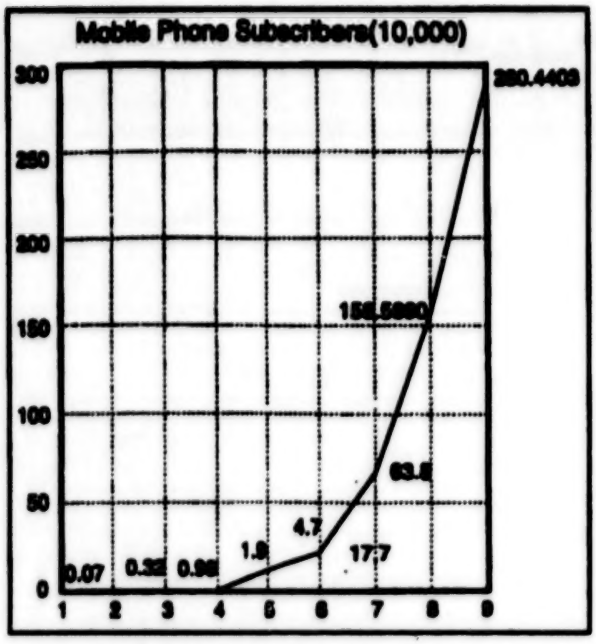

Figure 1. The Growth of the Number of Mobile Phone Subscribers in China

The analog TACS [Total Access Communications System] networks totaled 264 switches nationwide, with 7,660,000 lines, 3,063 base stations and 105,500 channels. In order to give full play to the overall efficiency of the PTT public TACS networks, nationwide internetworking was realized between Motorola and Ericsson systems of the same standard in early 1995. It is expected that by end-1995, wider roaming will be made available to the public as a result of further internetworking between the two systems.

Meanwhile, the construction of the PTT national digital GSM system is under full swing in parallel with the internetworking between the two systems. By September 1995, 15 provinces and municipalities had signed contracts for importing GSM systems from abroad, seven of which have launched digital mobile phone service by now. Internetworking tests are under way and automatic roaming is expected to be achieved between 14 provinces and municipalities.

Radio paging in China is open to non-PTT operators. While there are more than 2,000 operators participating in competition in this service, PTT is always dominant in the market, with its 14,810,500 subscribers, making up 80 percent of the total number. Now, while improving service quality and diversifying services, PTT is doubling its efforts to interconnect its public paging networks. The internetworked area is expanding nationwide based on realization of internetworking between the three provinces and one city in early 1995. (Figure 2: The Growth of the Number of Paging Subscribers in China)

As of 31 August 1995

No.	Year	Paging subscribers (10,000)
1	1985	0.4
2	1986	1
3	1987	3.08
4	1988	9.72
5	1989	23.73
6	1990	43.65
7	1991	87.38
8	1992	222.02
9	1993	560.39
10	1994	1027.36
11	1995	1481.05

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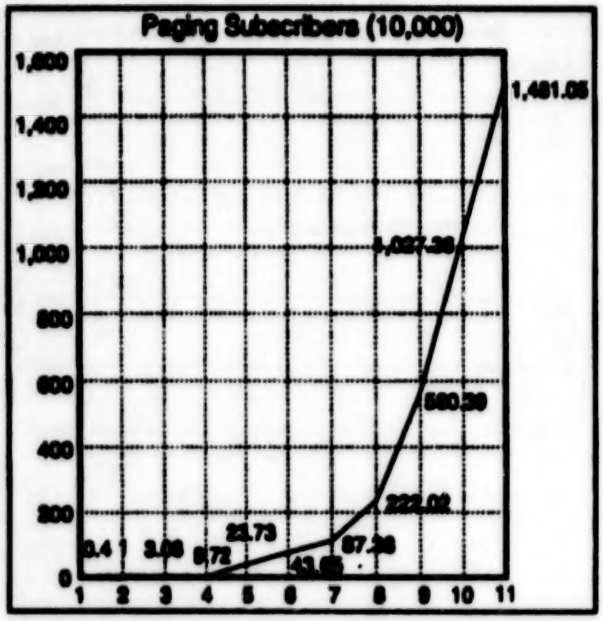

Figure 2: The Growth of the Number of Paging Subscribers in China

The development of mobile communications has the following characteristics:

1. Explosively Growing and Unbalanced Demand

With an extremely large population and an extremely low penetration rate of local telephony, China's demand for mobile phone service is brisk and has massive potential for growth. However, facts show that the distribution of mobile phone subscribers is very unbalanced, with a relatively high density of mobile phones in economically developed areas in the coastal areas in East and South China, and in the densely populated parts of a city.

In China, telecoms policies and tariffs are basically identical throughout the nation. Under such circumstances, economy and population distribution are main factors affecting the development of cellular mobile phone service. Therefore, compared with developed nations like the United States, China has only a small area suitable for operation of cellular mobile phone service. Besides, even in densely populated urban areas, inadequate power supply, unfavorable geographical environment, etc., tend to restrict the selection of ideal locations of base stations, thus affecting the cell splitting and reducing the utilization of frequencies.

2. High Demand on Coverage and Automatic Roaming

China is a nation with extensive political, economic and cultural interchanges between different places. There are always lots of people on the move. However, its real-time charging system is immature, and manual roaming and handset rental service inadequate, thus stimulating the Chinese mobile subscribers' demand for wider network coverage and for more automatic roaming. The 1995 statistics on the growth of the number of mobile subscribers show that it is the nationwide internetworking of mobile phone service that has greatly increased mobile subscribers.

3. Evolution From Local to Provincial, National and Even International Networks

In its initial stage, mobile communications in China was characterized by a certain degree of localization so as to satisfy the rapidly growing demand in time then. As conventional manual roaming no longer adapts itself to the situation, PTT public local mobile networks have incorporated into provincial networks and even a national network. The advent of the second generation mobile technology offered a powerful technical guarantee to internetworking at the international level. China's PTT public mobile network will incorporate into the international network, with the implementation of the national GSM network. The dream of global internetworking for mobile communications will soon come true.

II. Strategy for Development and Prospects

Facing the challenge of a liberalized mobile market, we will focus our effort on speeding up networking and internetworking, optimizing the established networks, improving the completion rate during busy hours and in busy areas, enhancing the overall capability of PTT mobile networks, developing new services and improving quality of service.

1. Speeding up Networking and Internetworking

Although the TACS system has advantages such as wide coverage, mature technology, no distortion, less expensive handsets, yet its disadvantages are low frequency utilization, poor security, high system cost, etc. Besides, the extreme disparity of the distribution of China's population and the restriction affecting the location of base stations have increased the complexity and difficulty of cell optimization. So, it is hard to meet the needs of subscribers solely by relying on the TACS System.

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On the other hand, the GSM system is developing the most rapidly among the four existing digital cellular mobile systems. It has passed its trial operation stage and features a frequency utilization rate 1.2 to 2 times higher than that of the TACS system, powerful internetworking capability, diversified services, international roaming, and less investment. CDMA [code division multiple access] is an efficient technology to accommodate large capacity with its high frequency utilization rate, simplified frequency planning and high resistance to interference. The construction of CDMA networks is under preparation.

Experience shows that one of the advantages of the PTT mobile networks is internetworking. Nationwide internetworking will enable functions such as automatic registration, call forwarding and transexchange (cell) handover, thus freeing mobile subscribers from going through complicated and time-consuming call request procedures in manual roaming. Therefore, the concurrent implementation of networking and internetworking is especially necessary in developing mobile communications. Presently, we are busily engaged in internetworking the TACS systems and GSM systems respectively and realizing nationwide internetworking for radio paging.

2. Optimization of the Established Networks

Since the national TACS network was established not long ago and traffic is growing fast, problems exist in the process of operation of the network. What must be done for the time being is to tap the potential of the TACS network to increase its completion rate by rationally arranging radio channels and planning frequencies, and to minimize interference. Also important is to establish good network management and charging systems and to tighten operation, maintenance and management so that current operation status over the networks can be obtained and analyzed.

- To rationalize the coverage by optimizing the distribution of cells and increasing the number of base stations.

Whether the coverage of a mobile network is rational directly affects the provision of service. Being the first imported mobile phone system in China, the present TACS is not quite rational in terms of coverage. For example, there is great difference in intensity of signals between different parts of a city, and radio shielded places like underground railways, tunnels and basements remain uncovered by mobile service. It is imperative for us to rationalize the coverage by optimizing the distribution of cells and increasing base stations. By the end of 1997, we expect to cover all the county seats and economically developed townships and 95 percent of urban areas in Central and East China. Uninterrupted coverage will be achieved over major trunk lines of highways, railways and inland navigation. As to West China, all the prefecture capitals and part of the county seats will get services. In local mobile networks, the completion rate of calls from fixed subscribers to mobile subscribers will reach 30 percent during busy hours and in busy areas.

- To minimize co-frequency interference by tightening frequency planning.

Frequency planning is particularly important in developing mobile communications. Poor frequency planning leads to poor coverage and serious interference. Since frequency planning closely relates to topography, it should be done by well-trained professionals, who can conduct dynamic analysis and give guidance for the coordinated development of the whole network, with a view to improving networking quality and the service scope of the network.

- To tighten operation, maintenance and management of networks and establish a national network management centre and a charging centre for mobile communications.

As the central nervous center that regulates, commands and controls the whole network, the national network management centre is a powerful mechanism to tighten operations, maintenance and management of networks. In the meanwhile, the launching of automatic roaming has greatly increased accounting volume of the charge incurred by interprovincial roaming. A charging centre will efficiently sort the telephone tickets for interprovincial roaming.

3. Provision of New Services and High Quality Service

- To provide new services by making use of existing system capability. Existing mobile network systems can provide various additional services. By making use of the point-to-point and cell short message broadcasting service provided by GSM networks, mobile stations are able to transmit and receive short messages during idle time and in the process of calling. Besides, through voice mailbox, GSM subscribers can use call forwarding with any call so as to have the call answered in areas where no mobile service is available. They can draw information through voice mailbox, using any handsets. TACS subscribers can use services like call-while-roaming, call-while-tracking, etc., after nationwide internetworking is achieved.

- To strengthen management of services.

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In regard to services, market-oriented management should be strengthened so as to form an operational system to accommodate demand for diversified services.

Mobile communications in China has a bright prospect for great expansion. It is planned that by end-1997, the number of mobile and paging subscribers will be 8 million and 23 million, respectively. Internetworking of the TACS systems will be completed, and internetworked operation and international roaming of the GSM network will be realized. For PTT-operated public paging, all the leading cities will be internetworked at 152.650 MHz, 151.350 MHz and 150.725 MHz, and a nationwide paging network operating at at least four frequency points of the 280 MHz band will be cut over. Besides, we will closely follow the trend of mobile communications technologies both at home and abroad and spread new mature technologies and further reform our organizational structure so as to adapt it to the special features of mobile communications and a market economy.

China: Experimental Optical Buffer, 2 x 622-Mbps ATM Photonic Switching System Developed

96P30180A Beijing GAO JISHU TONGXUN [HIGH TECHNOLOGY LETTERS] in Chinese Mar 96 Vol 6 No 3, pp 15-18

[Article by Zhang Zhijian [1728 1807 1017], Guo Yili, Zhang Hanyi, Li Dejie, and Zhou Bingkun of the Dept. of Electronic Eng., Qinghua Univ., Beijing 100084, research supported by grant from 863 Program; MS received 27 Mar 95]

[FBIS Summary] ATM [asynchronous transfer mode] technology is the basis for the B-ISDN [broadband integrated services digital network] research now under way in China and elsewhere. In this paper, a new optical-buffer structure for resolving ATM cell contention is presented. This buffer consists of two fiber delay lines, five 2 x 2 $LiNbO_3$ waveguides forming an optical switching array, and three nonlinear semiconductor optical amplifiers (NSOA). Based on this new optical-buffer structure, an experimental 2 x 622-Mbps photonic switching system for ATM cells formed by data sent at different transmission rates (up to 622 Mbps [the SDH STM-4 standard]) from different users has been developed. The throughput of this system is 1.2 Gbps.

Figures 1, 2, 3, 4, and 6, not reproduced, show a notional drawing of the new buffer structure, an integrated optical waveguide structure, the optical-buffer operating principle, a schematic of the interconnection of the various stages of the optical buffer, and a graph of the characteristic curve (P_{out} vs P_{in}) for the NSOA, respectively. Figures 5, 7, and 8, showing the detailed structure of the new buffer, the principle of the ATM photonic switching system, and a schematic of a 4 x 4 optical ATM switching network, respectively, are reproduced below. There are no tables.

References: 5 English.

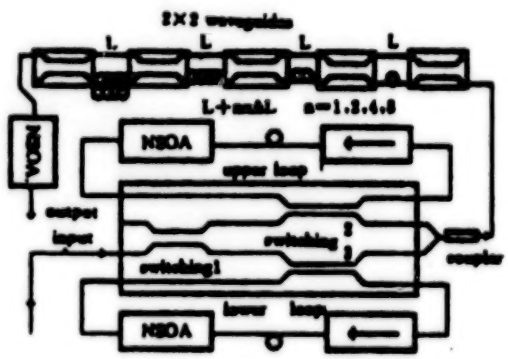

Figure 5: Detailed Structure of the New Optical Buffer

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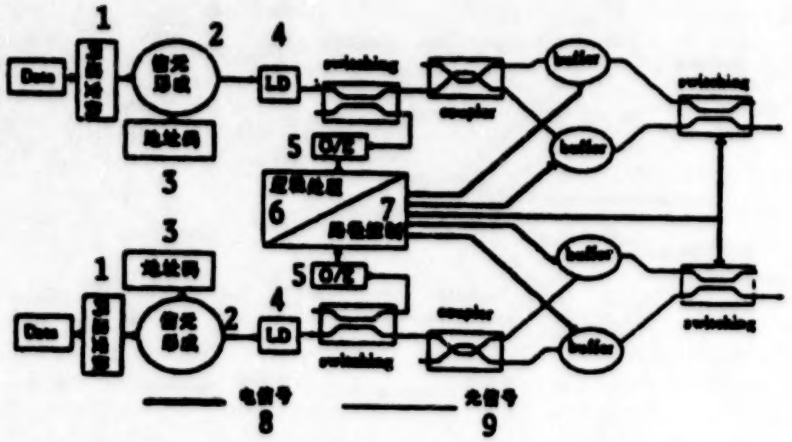

Figure 7. ATM Photonic Switching System Principle

1—bit-rate converter, 2—cell forming, 3—address code, 4—LD = laser diode, 5—O/E = optical-to-electrical signal converter, 6—logic processing, 7—path control, 8—electical signal, 9—optical signal

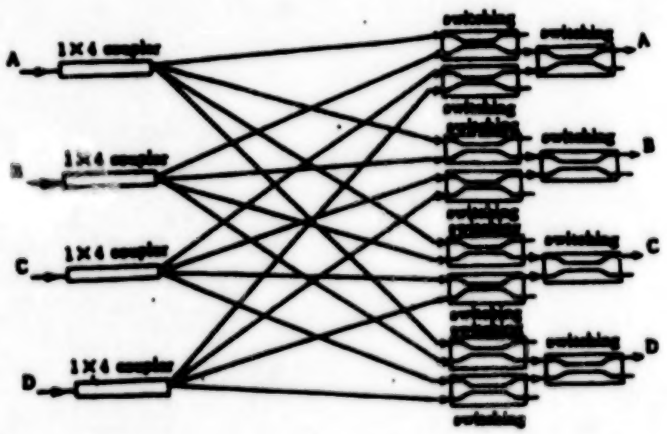

Figure 8. Schematic of 4 x 4 Optical ATM Switching Network

China: Application of Chaos in Information Encryption

96P30188A Beijing KEXUE TONGBAO [CHINESE SCIENCE BULLETIN] in Chinese 1-15 Mar 96 Vol 41 No 5, pp 402-405

[Article by Dai Jianhua, Yin Huawei, Zhang Hongjun, and Wu Ling'an of the CAS Institute of Physics, Beijing 100080, research supported by grants from NSFC and the State Climbing Program; MS received 25 Sep 95, revised 22 Nov 95]

[FBIS Summary] The recently popular theory of using the initial value sensitivity in chaotic systems to achieve secure communications—especially the use of chaotic synchronization in Chua's circuit—is discussed. According to these chaos-based characteristics, the authors propose a new information encryption method. Experiments demonstrate that the method is quite feasible for effecting secure communications.

Seven figures, not reproduced, show a schematic of the encryption/decryption process, fixed-system bifurcation plots, experimental results of original texts (both English and Chinese) and their enciphered and (after digital transmission) deciphered counterparts, a schematic of an image encryption/decryption process, the encryption/decryption process for a time-series signal, decryption results for signal of previous figure after change of parameter A [amplitude] to 10^{-6}, and decrypted results

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for same signal [a square-wave signal] with varying noise intensities (20, 10, and 1 percent). There are no tables.

References: 6 English (including 2 by the authors).

China: Shanghai InforPort Project Completes "1 Network, 5 Databases" Campaign

96P30188B Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese Apr 96 No 4, p 17

[FBIS Summary] Shanghai P&T Management Bureau Director Cheng Xiyuan recently announced that construction for the Shanghai InforPort Project's first campaign—the "1 Network, 5 Databases" sub-project—would be completed by 30 June 1996. The "1 Network" indicates Shanghai's local-network public information network, provisionally called "SHANGHAINET." The five databases are as follows: (1) a news database; (2) a large yellow-pages database, including local telephone numbers, mobile numbers, fax numbers, and postal codes; (3) a travel-information database; (4) an economic-information database; and (5) a foreign database(s). The most important goal of this campaign is the introduction of a variety of new information services, whose success will be dependent on completion of the subscriber fiberoptic cables now being laid and integrated into Shanghai's wired telecommunications network.

China: 2.5-Gbps Beijing-Shenyang-Harbin Fiberoptic Cable Laid

96P30188C Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese Apr 96 No 4, p 48

[News brief by reporter Wu Quanxi]

[FBIS Summary] Using a third Japanese loan, MPT is building the world's longest-range, largest-scale, one-time-built high-bit-rate fiberoptic cable—the 2.5-Gbps [i.e. the STM-16 standard in the SDH (Synchronous Digital Hierarchy)] Beijing-Shenyang-Harbin fiberoptic cable. Engineering drawings for this project have been completed by MPT's Design Institute and construction is being overseen by MPT's 1st, 3rd, and 4th Engineering Bureaus. Construction began in March and is to be completed by the end of June this year. The project uses 1550-nm-wavelength fiber, carries over 30,000 circuits per pair of fibers, and employs optical transmission equipment made by Germany's Siemens (selected from 11 foreign manufacturers via open tender offer). This 4600-km-long cable, interconnecting 89 offices and stations, runs from Beijing through Tianjin, Hebei Province, Inner Mongolia, Liaoning Province, Jilin Province, and Heilongjiang Province. Gross project investment is almost 200 million RMB [$23.87 million].

China: Five Kinds of ISDN Terminal Certified

96P30188D Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese Apr 96 No 4, p 48

[FBIS Summary] Five kinds of utilitarian ISDN (Integrated Services Digital Network) terminals developed in a State Eighth FYP Key S&T Tasks project have been certified in Beijing. These five products are as follows: (1) a digital telephone, (2) a terminal adaptor (TA), (3) a category-1 network terminal (2B+D NT1), (4) a black-and-white videophone, and (5) a multifunctional terminal (TE1). All of these terminals comply with domestic specifications (spelled out in the "State Eighth FYP Key Task ISDN Experimental Network Technical Specifications" and "Eighth FYP ISDN Experimental Network Group Network Equipment Technical Specifications") and with ITU-T international recommendations.

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China: Further Details on Hybrid Reactor Research Released

963A0029A Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 1 Jan 96 p 1

[Article by Liu Xiaoge [0491 1420 7245]: "Major Accomplishments in China's Hybrid Reactor Research"; cf. FBIS-CST-96-001, 23 Jan 96, p 37]

[FBIS Translated Text] According to reports at an expert group meeting on the hybrid reactor program, part of the energy category of the 863 Program, that was recently held in Chengdu, major advances in hybrid reactor research made during the Eighth 5-Year Plan will provide a powerful stimulus for the progress of controlled nuclear fusion in China.

The hybrid reactor program includes five projects. Under the high-power HL-1M edge plasma study with multiple auxiliary systems, undertaken by the nuclear industry's Southwest Institute of Physics, in October 1994 the reconstruction of a new model circulator was completed and it was put into experimental operation, with a toroidal magnetic field of 2.5 teslas, a plasma current of 325 kA, and a plasma lifetime of 1040 milliseconds. Recently, a lower hybrid wave drive experiment with advanced plasma characteristics was successfully performed with the HL-1M facility, fully meeting the requirements of the 863 Program. In addition, the development of the HL-1M facility's multiple pellet injection system, ash removal system, and megawatt-class neutral beam injection system are scheduled to be completed within the year.

In a plasma research project at the Hefei Plasma Institute, CAS, power has now been generated for the first time at the HT-7 superconducting tokamak facility, with a superconducting longitudinal field of 2.5 teslas, a plasma current of 160 kA, and a plasma lifetime of 300 milliseconds. The resonant heating system for the facility's megawatt-class long-pulse ion circulator is also nearing completion.

The other three projects under the hybrid reactor program for the Eighth 5-Year Plan were also fully completed. They were: a study of hybrid-reactor objectives for the year 2000, a detailed conceptual design study for the hybrid reactor, and a study of materials and processes for the hybrid reactor.

China: PhD Dissertation on HT-7 Superconducting Tokamak Technology Highlighted

963A0029B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 5 Jan 96 p 3

[Article: "Thermal Analysis and Stability Study of Superconducting Magnet Systems for the HT-7 Superconducting Tokamak Facility" (feature heading: "Doctoral Dissertations in the Natural and Engineering Sciences)"]

[FBIS Translated Text] After describing leading-edge world technology in nuclear fusion research and discussing the design and characteristics of the HT-7 superconducting tokamak, this dissertation addresses the following topics:

(1) Thermal load analysis of the liquid nitrogen and liquid helium systems indicates that the cooling system is capable of maintaining the desired conditions. When the liquid helium temperature is 4.5 K, the surface temperature of the aluminum magnet housing is 6.1 K.

(2) The temperature difference between the nitrogen screen and the magnet during the initial stage of cooling must not exceed 30 K; 70 to 80 hours will be required in order to cool the magnet from 300 to 80 K. Calculations dealing with the use of compressed helium or a two-phase flow of helium to cool the magnet yielded results comparable with measurements made on the original apparatus, demonstrating that the computation method was practicable.

(3) Taking advantage of the characteristics of the magnet, a three-dimensional numerical model of the cooling process was replaced by a two-dimensional model. A one-dimensional model also produced results that were in good agreement with measurements. A new computational procedure developed for the purpose, using an "alternating-transformation iteration method," was effective in modeling heat transfer and flow conditions in a magnetic winding of the internally cooled, hollow-core type magnet that is used at the facility. The algorithm converges rapidly and requires little computation time.

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(4) A detailed study of the stability of the superconducting magnet in its planned operating environment dealt primarily with the way in which superconductivity was affected by the pulse generated by collapse of the poloidal field and the plasma current. It demonstrated that when the operating current of the superconductor is 6300 A, the helium coolant must be maintained in two-phase flow at a temperature of 3.8 K or less. With cooling by compressed helium or by a constant-pressure two-phase flow of helium, the magnet current must not exceed 5500 A.

(5) A study of requirements for the loss-of-superconductivity protective system of the magnet showed that with an energy transfer resistance of between 0.06 and 0.13 ohms, the energy collector voltage threshold should be 22 MV at 6300 A and 28 MV at 5000 A.

(6) Evaluation and numerical analysis of the load-bearing capacity and strength of the structural supports for the magnetic coil and aluminum housing showed that the stress produced by the coil did not exceed the yield strength of copper and would not affect the critical characteristics of the materials. But the structural supports for the magnetic coil and housing are rather light, and the mean overall stress produced by the unit is close to the yield stress of the supports.

(7) In an analysis of the operating cycle of the magnet, under the assumption that a 1-mm frost layer would be present for a maximum of 2 months, the surface magnetic [garbled text] rate would not exceed 5 A/s. The theoretical prediction of the helium temperature within the magnet windings after loss of superconductivity was in satisfactory agreement with measurements performed during initial experiments.

Title of dissertation: Thermal Analysis and Stability Study of Superconducting Magnet Systems for the HT-7 Superconducting Tokamak Facility

Author: Gu Pingdao [7357 1627 6670]

Date of acceptance: January 1995

Directors of dissertation: Qiu Lijian [6726 0536 0313] and Wang Minghua [3769 6900 5478].

Institution awarding doctoral degree: Institute of Plasma Physics, CAS.

China: CAS, Shanghai Municipality Discuss Designs for Shanghai Synchrotron Radiation Facility

963A0029C Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 15 Jan 96 p 1

[Article by Huang Xin [7806 6580]: "CAS and Shanghai Municipality Experts Discuss Synchrotron Radiation Facility Designs"]

[FBIS Translated Text] Shanghai—The Shanghai municipal government and the Chinese Academy of Sciences recently held a feasibility-stage work and report session on a projected synchrotron radiation facility for Shanghai, at which Shanghai Deputy Mayor Hua Jianmin [5478 1696 2404], CAS Executive Deputy Director Lu Yongxiang [6424 3941 4382], and 21 eminent scientists from around the country, including 15 academicians of the CAS, evaluated the plans and made constructive suggestions.

The CAS and the Shanghai government last August signed a formal agreement on the application to build a synchrotron radiation facility. CAS researchers made a thorough study in a rigorously scientific spirit and presented the leadership with four alternative physical designs, together with plans for the first group of optical beam buildings and laboratory facilities.

The Shanghai synchrotron radiation facility is expected to achieve an electron energy of 2.2 billion electron volts, 10 times the energy attainable by third-generation synchrotron radiation sources now in operation or under construction elsewhere in the world. Its energy storage ring will have a circumference of about 300 m. The facility will include life science, materials science, medical diagnosis, microelectronics, and micromachining laboratories.

China's First Conventional-Guideway Maglev Train Operates Successfully in Lab

963A0029D Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 30 Jan 96 p 1

Article by correspondent Li Gang [2621 1511] and reporter Zhu Huilun [2612 2585 0243], edited by Zhou Ganpu [0719 2413 2528], Wang Shufen [3769

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3219 5358], and Zhang Ke [1728 0344]: "China's First Manned Conventional-Guideway Maglev Train Performs Well in Laboratory"]

[FBIS Translated Text] Chengdu, 29 January—China's first 40-ton passenger-carrying conventional-guideway maglev [magnetic levitation] vehicle was successfully operated today in a huge laboratory at Southwest Jiaotong University in Chengdu. Experts from all over the country gave it high praise. This event means that the use of passenger maglev trains in China is no longer just a dream. In addition, it demonstrates that China's land transportation technology has reached the world state of the art.

Magnetic levitation trains are non-contact transportation systems that are levitated 8 to 10 mm above the running surface and are propelled by linear asynchronous electric motors. Because there is no mechanical contact of wheels with track, speeds as high as 500 km/hour can be reached, with an extremely smooth and comfortable ride. The safety factor is 700 times that for motor vehicles, 250 times that for ordinary trains, and 20 times that for aircraft. Maglev trains produce no air pollution, develop high power with low energy consumption, and have excellent grade-climbing ability. They have been described as an advanced land transport tool for the 21st century. Since the 1960's, the developed western countries have been competing in their development at great expense. Germany, Japan, and the UK have created test tracks of various lengths.

China began maglev research in the 1980's. The Southwest Jiaotong University succeeded in developing its maglev vehicle in October 1994 and laid a 43-meter-long advanced test track for it. The production-model vehicle has spacious standard passenger seats. Two magnet frames, the car and the guideway form a complete prototype maglev operating system. The 4-ton weight [as published] of the unit is levitated 8 mm above the track. On the 43-meter test track, a speed of 5 km/hour is attained when the vehicle is driven by onboard GIR inverter, and a speed of 10 km/hour is attained when it is driven by a ground-based GIR inverter. Major improvements were made in 1995, greatly enhancing speed, comfort, and the engineering quality and practicability of the track and other systems.

Experts say that the dream of passenger maglev trains in China is destined to become a reality. The passenger conventional-guideway maglev train and test track passed their expert evaluations today.

China: Multibeam Klystron—New Type of High-Power Microwave Amplifier

96P30177A Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Jan 96 Vol 18 No 1, pp 64-71

[Article by Ding Yaogen [0002 5069 2704] and Peng Jun [1756 6874] of the CAS Institute of Electronics, Beijing 100080, research supported by grant from NSFC; MS received 17 Oct 94, revised 5 Mar 95]

[FBIS Summary] A new type of high-power microwave (HPM) source—the S-band multibeam broadband klystron, with megawatt-class power and an operating voltage of 70-80 kV—is described. These devices are about 1.5 meters long and weigh about 70 kg, plus about 300 kg for the focusing assembly. The development of this klystron is commented on briefly and its principle and main characteristics based on the klystron-cavity fundamental mode of operation are detailed. The effect of the device parameters on the operating bandwidth and output power are also studied, and the power limitation is reported. Finally, key technical problems and development trends for this HPM source are discussed.

The CAS Institute of Electronics has been engaged in R&D of this klystron since 1992. A 200-kW [i.e. 0.2-MW] S-band multibeam broadband klystron is now under development at the institute. Additional parameters of this device are as follows:

- operating mode is TM_{010}
- wavelength is 12.5 cm
- efficiency is 40 percent
- cavity diameter is 6.25 cm
- cavity gap is 0.6 cm
- total perveance is 10-20 μP
- single e-beam perveance is 0.3-0.6 μP
- overall device cathode emission current density is 15 A/square cm
- operating voltage is 18 kV
- control-electrode voltage is 6-7 kV
- interaction length is 250 mm
- focusing magnetic field is 1200 gauss
- magnet weight is 13 kg

Tables 1 and 2, not reproduced, list parameters for foreign multibeam broadband klystrons. Figure 1, not reproduced, shows a device schematic, while Figures 2-7 are graphs of performance under various changes of operating parameters.

References: 1 USSR patent, 1 French patent, 2 European patents, and 9 English journal references.

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China: Onshore Oil Exploration and Output in 1995

963A0035A Chengdu SICHUAN RIBAO in Chinese 5 Jan 95 p 4

[Article: "Newly Discovered Geological Petroleum Reserves Reach 590 Million Tons; Onshore Oil and Gas Output Sets New Record"]

[FBIS Translated Text] NCNA, Beijing, 4 January—China's onshore petroleum industry added new explored geological petroleum reserves of 590 million tons and gas reserves of 77.6 billion cubic meters in 1995, overfulfilling the state plan and providing valuable reserves for the continued development of the petroleum industry. The onshore petroleum industry had a total of 52 major exploration successes during the year, including 22 major oil and gas discoveries, 12 major advances in exploration, and 18 significant new prospecting leads, which have resulted in excellent prospects.

NCNA, Beijing, 4 January—The national onshore petroleum industry overfulfilled its 1995 output assignments five days ahead of schedule and set a new output record.

The total crude oil output from onshore oil fields in 1995 was 140.32 million tons, 1.31 percent above the state plan target, and the assignment was completed 5 days ahead of schedule. The crude oil output exceeded the 1994 figure by 880.6 thousand tons and was the first yearly total above 140 million tons. The output of natural gas from onshore oil fields was more than 16 billion cubic meters, likewise fulfilling the state plan assignment and setting a record.

China: Onshore Oil Industry Development Strategy for Ninth 5-Year Plan

963A0035B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 4 Oct 95 p 1

[Article by Qu Jian [4234 0494]: "China's Onshore Petroleum Industry Enters New Phase of Development"]

[FBIS Translated Text] Where should the funding for enterprise science and technology investment come from? At its fifth S&T conference, recently concluded at Daqing, the China National Petroleum Corporation declared that the funds should be freed by cutting back on minimally productive or unproductive exploration and development, strictly controlling the allocation of funding, reducing the number of nonproductive construction products, altering the economic growth model, and making greater use of science and technology.

To this end, the corporation's past practice of providing block funding for its directly subordinate S&T research organizations will be replaced by a new project-by-project funding approach designed to obtain a greater yield from S&T efforts. This is just one of many new steps being taken by the corporation in order to transform its governmental functions and reform its S&T management. This series of major actions affects the entire strategy of China's onshore petroleum industry. In combination with eight major S&T programs to be undertaken by the petroleum sector during the Ninth 5-Year Plan, it will open a new phase of the onshore petroleum industry's development.

China's annual output of 140 million tons of crude oil and 16 billion cubic meters of natural gas has established it as a world leader, and it is likewise a leader in many petroleum exploration and development technologies. But solutions are sorely needed for many difficult technical problems in gas exploration, oil and gas field development, production operations, and transnational operations. China's onshore petroleum industry is currently in a special stage of its development, in which its reliance on science and technology is more urgent and important than ever before.

In response to the situation, the China National Petroleum Corporation has announced a new approach to the development of the onshore oil and gas industry for the Ninth 5-Year Plan and the new century, in which it will change over from massive labor inputs to a reliance on the latest S&T advances and on scientific management in order to increase reserves, output, and efficiency. Borrowing from the experience of foreign oil companies, the industry will convert its ministry organs, which hitherto have performed only governmental management functions, to economic benefit-centered organizations. It will then adopt an entirely new set of operating methods that will constitute a major reform of the S&T management system, especially the key area of S&T funding. It will gradually institute project-by-project funding and total-cost accounting for every project. Scientific research projects will be brought under a contract-based system of management with tightened oversight and auditing of the spending of S&T funds so as to prevent diversion and waste. The industry will also emphasize the recovery of S&T expenditures and will make available a variety of approaches, such as full funding, assistance, interest-free or low-interest loans, and compensated use, that can be selected as the nature of particular projects requires. Applications projects will be carried out on a compensated-use basis, gradually giving rise to a beneficial input-output cycle.

During the Ninth 5-Year Plan, the corporation will also devote major efforts to eight S&T projects (oil and gas exploration; oil field development; the exploration, development and integrated utilization of natural gas; oil refining and petrochemistry; creating high-technology

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and new-technology industries; and enhancing its capabilities in technology, policy science, information science, and training), along with efforts in 32 ancillary technologies. Work on the above projects during the Ninth 5-Year Plan will solve a group of difficult technology problems, including the extraction of oil from pools with high and extra-high water content. All conventional technologies will be brought up to the early 1990's world state of the art; the rate of utilization of S&T results will be increased to 90 percent and the contribution rate of S&T progress to 60 percent; and the economic benefits realized from oil and gas exploration and development will be increased by 15 percent.

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Development of Wind Power in China

963A0033A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 2 Oct 95 p 5

[Article by Liao Shixiong [1675 0013 7160] and Yu Zhengdao [0151 2973 6670]: "A Promising Energy Source, Trend and Outlook"]

[FBIS Translated Text] As the economy grows, wind power is becoming a new branch in the development of energy resource. What is the status of development and utilization of wind power in China? How are we going to develop wind power in the next century? To answer these questions, the authors visited He Dexin [6320 1795 7451], vice president of the Chinese Society of Solar Energy.

Wind Power Has a Long History

Vice President He pointed out that China is among the very first countries in the world to utilize wind power. It began as early as more than 3,000 years ago. Wind power was used in sailing and water pumping. In the 1950's, wind generator and wind powered water pump were developed. In the 1960's modern wind powered water pump was developed. Since the mid 1970's, fossil fuel and electricity have been in short supply and pollution is getting much worse, people are becoming more aware of wind power as a clean renewable energy resource. Utilization of wind power in China is entering a new era.

To date, China has 140,000 micro wind generators ranging from 50 W to 200 W operating in Inner Mongolia, Xinjiang, Qinghai and Gansu and along the coast where the power grid does not reach. It supplies electricity to a large number of farmers and ranchers. We can commercially produce small to medium wind generators ranging from 1 kW to 100 kW and are developing 200 kW units. A great deal of progress has also been made in wind-powered water pumps. There are over 1,000 wind powered water pumps across China.

China is not abundant in conventional energy resources. However, it is rich in wind energy. Seventy-six percent of the area can benefit from wind power with a usable resource of 2.5 trillion kW. Developing wind power not only has social benefits but also economic and environmental benefits as well.

Wind Power Development Leads to Prosperity

Wind-powered water pump is an effective way to produce much needed energy in an area where wind and water are abundant. In the Xiao district of Tianjin, a total of 100 wind-powered waters pumps, Model TFS-5 and FDG-5, have been installed since 1990 primarily for irrigation. Each unit is capable of replacing a 4.5 kW submerged electric pump to cover 150 mu (10.05 ha) of farmland. Each unit can save 5,000 kWh of electricity annually and can increase crop yield by 15 percent.

Micro wind machine is becoming an independent source of electricity in remote areas in China. Electric energy generated by micro (under 1 kW) or small (1 - 10 kW) wind machines can be stored in batteries and then converted from dc to ac to power TV sets and other household appliances. Medium and large size wind machines are primarily used to alleviate the shortage of electricity in far reaching areas of a power grid where wind power is abundant. A small scale wind power plant is comprised of medium and large size wind machines. In 1986, three Danish made 55 kW wind machines were installed in Rongcheng, Shangdong and began to operate in parallel to a power grid. It is China's first wind power plant. Since, wind power plants have been built in Pingtan, Fujian; Nanhau, Guangdong; and Dabancheng, Xinjiang. As of the end of 1994, the overall installed capacity has exceeded 30 MW. The operation has been profitable. Nanhau, Guangdong is known as the "windy county." The year-round average wind speed is 8.45 m/sec. The county government is very enthusiastic about developing wind power. Since 1985, three phases of wind power projects have been completed. In 1993, the annual average electricity generated reached 416,000,000 kW h. In Nanhau, wind power accounts for one-fourth of total electricity generated on the island. In addition to developing and utilizing wind energy, we should also be engaged in basic research in related fields, such as wind tunnel testing of wind machine, wind farm measurement technology, running windmill generator and diesel generator in parallel, and developing high performance generator, storage battery and water pump as accessories to wind machine.

Wind Power Has a Bright Future

After a decade of hard work, wind power has been substantial progress in China. Nevertheless, there are still 30 counties in China that are yet not electrified. Approximately 17 percent of the farmers and ranchers (about 200 million people) do not have access to electric power. In addition, coal is the primary source of energy in China and environmental pollution is a serious issue. To this end, the government is very serious about developing new and renewable energy sources. Wind power is the most promising energy source. Recently, the Ministry of Electric Power Industry has planned to expand the total installed capacity for wind power to 400 MW by the end of this century. The basic policy is to focus on small privately-owned facilities to supply electric power for the people for their daily use. In remote areas without electricity, micro wind

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machines will be installed at each individual household. In remote villages and on inhibited islands, we will actively develop independent wind power systems and wind/diesel systems to alleviate the shortage of diesel fuel. In economically developed areas, if wind resource is abundant locally and demand for electricity is large, we plan to build large scale wind farms to convert wind energy to productivity. On the basis of importing foreign technology, we will develop our own 200 kW or larger wind generators to meet our needs.

Utilization of New Energy in China

963A0033B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 18 Sep 95 p 2

[Article by Li Jianmin [2621 1696 3046]: "Heavy Utilization of New and Renewable Energy in China"]

[FBIS Translated Text] According to the Chinese government, various new and renewable energy sources are accountable for one-fourth of the overall energy supply. That corresponds to over 300 million tons of standard coal annually.

New and renewable energy resources, such as water, wind and geothermal energy, are abundant in China. It becomes an integral part of China's energy supply and plays an important role in promoting economic growth and supplying daily energy needs for people in rural and remote areas.

To date, there are more than 60,000 small hydroelectric power plants in China. Electricity is accessible in 97 percent of the villages, 92 percent of the small township and 87 percent of the rural households.

Furthermore, utilization of wind power is expanding. It has a total installed capacity of 26,000 kW and there are 120,000 small wind machines spread along the border and the coast. In the eighth 5-Year Plan, effort is directed toward development of large and medium wind machines. In addition, 20 wind farms are built in Xinjiang, Inner Mongolia and Guangdong.

In solar energy, solar hot water heating has been expanded to cover 2.5 million square meters. There are 340,000 hectares of solar greenhouse and 140,000 solar stoves. In order to supply electricity to remote areas, the government has constructed solar power plants in Inner Mongolia, Gansu, Xizang and Qinghai. Biomass is becoming a major energy source in rural areas. Methane gas production and supply is being centralized. It has evolved from simple fuel production to comprehensive utilization. To date, there are 5,250,000 methane pits producing 1.2 billion cubic meters of methane annually. Advanced large scale methane production facilities capable of producing thousand of cubic meters each are being built in Shanghai and Zhejiang. In addition, geothermal energy is rapidly being developed in Xizang, Xinjiang and Qinghai. For example, the Yangbajing geothermal power plant in Lasa has an installed capacity of 25,000 kW. It is a major power plant in the power grid of Lasa.

China: Status, Plan of Wind Power Generation in Inner Mongolia

963A0033C Beijing SHUILI FADIAN [WATER POWER] in Chinese 12 Jan 96 No 1, pp 54-55

[Article by Zhao Fengshan [6392 7364 1472] of the Electric Power Bureau of Inner Mongolia Autonomous Region: "Status, Plan of Wind Power Generation in Inner Mongolia," MS received 10 August 1995]

[FBIS Translated Text] Wind power is a hot subject in 1995. There are three major national meetings. A workshop for early stage preparation for wind power was held at the beginning of the year. An international wind power conference was held in Beijing in May. In August, an on-site meeting on wind farm construction and management was held in Xinjiang. It was widely reported on TV and newspaper. With support from the Ministry of Power Industry, the State Planning Commission, the State Economics and Trade Commission and the National Development Bank, things are moving fast. During his visit to Inner Mongolia in March to preside the ribbon cutting ceremony for the Shangdu Wind power plant, Vice Minister Wang Shucheng [3076 1859 6134] pointed out that wind power development should be directed toward commercialization. The Inner Mongolia Autonomous Regional government is planning to develop wind power in a large scale. Inner Mongolia has the potential to develop wind power and the future appears to be very promising.

1. Wind energy resource is abundant in Inner Mongolia.

Wind energy resource is abundant in the Inner Mongolia Autonomous Region. There is a wide band of usable wind speed and it is rarely too high to be destructive. It is also easy to connect to the existing power grid. An early stage survey showed that the region has a total wind energy capacity of 1.01 billion kW; out of which 101 million kW can be harnessed. In recent years, wind power is a focus of the Bureau of Electric Power in Inner Mongolia. It has devoted manpower and materials to this area starting from early stage preparation work. Since December 1993, a total of 12 wind speed measuring towers have been installed at a wind farm in Huitengxile. During a period of 14 months, wind resource covering an area of 100 Km2

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was surveyed using advanced wind speed measurement equipment. A great deal of data was obtained. In March 1995, the data and other relevant information were rigorously reviewed by experts from the U.S., Denmark, Japan and China. It was concluded that the wind energy resource is abundant and evenly distributed throughout the year. Excessively high and damaging wind is rare. It is close to a major power grid and is easily accessible by existing transportation infrastructure. Therefore, it is an ideal site for a major wind farm. The Bureau of Electric of Inner Mongolia prepared a plan in 1994 to develop this site. The plan calls for the development of this site to 360 MW by the year 2000, 800 MW by 2010 and 2,680 MW by 2020.

2. Status of wind power development in Inner Mongolia.

Since putting five U.S. made wind machines into operation in 1990, the Bureau of Electric Power of Inner Mongolia has imported a total of 45 wind machines in six stages. As of the end of 1994, the overall installed capacity is 8,075 kW. There are 28 units at Zhurihe (eleven 100 kW units, ten 120 kW units, four 250 kW units and three 300 kw units) with a combined capacity of 4,200 kW and 17 units at Shangdu (five 55 kW units and twelve 500 kW units) with a combined capacity of 3,875 kW.

In 1995, the two sites are scheduled to generate 16 million kW h of electricity. As of the end of June, 7.71 million kW h of electricity was generated; i.e., 3.326 million kW h at Zhurihe and 4.384 kW h at Shangdu. In the first half of 1995, the individual unit capacity coefficient is 0.33. The combined capacity coefficient for 12 units is 0.296.

3. Result of wind power development in 1995 is encouraging.

In recent years, with support from the Ministry of Electric Power Industry and other authorities, wind power construction is picking up pace and installed capacity is increasing year after year. An additional 11,800 kW of installed capacity is scheduled for 1995. It includes four 250 kW units jointly manufactured by Germany and China which are scheduled to go into production in October. Nine 600 kW units will be imported from Denmark under a Danish government guaranteed loan. Each of those units has a 43.4 m windmill. It is the largest wind machine in China. In addition, eighteen 300 kW units will be imported under a Dutch government guaranteed loan.

4. Wind power development plan in Inner Mongolia

In early 1995, the Bureau of Electric Power of Inner Mongolia ordered the Institute of Electric Power Design of Inner Mongolia to prepare a wind power development plan and to study the feasibility of constructing a 200 MW wind farm at Huitengxile. In early March, the Institute of Hydroelectric Power and Water Resource reviewed and approved the report on the feasibility of building a first phase 20 MW facility at Huitengxile. At the end of march, the State Economic and Trade Commission issued its guideline for engineering projects that will lead to technological innovation. It includes the construction of a 200 MW wind farm at Huitengxile by importing advanced large capacity wind machines. Phase 1 of the project is to build a 20 MW facility in 1996 - 1997. The Bureau of Electric Power of Inner Mongolia will be strictly responsible for all aspects including investment, engineering and quality and the plant is scheduled to be completed in 1997.

In addition, it is working on a joint venture with the NTK Corporation of Denmark and Shunfeng Corporation of U.S.A. to further develop Huitengxile. The plan is being submitted for approval.

In order to commercialize wind power, the Bureau of Electric Power of Inner Mongolia established the Inner Mongolia Wind Power Development Corporation. It will have its own accounting system and be independently operated and have its own development plan. This is to follow the policy of "reorganization as a corporation, commercial operation and legalized management." The corporation is slotted to have 90 employees and 60 million yuan of fixed assets. It has a technical team in infrastructure construction, production and design research and it is making good progress in managing wind power plant construction and operation.

5. Problems encountered in wind power development and recommendations

5.1 Straightening out pricing is the key to developing wind power.

In order to promote wind power, the Ministry of Electric Power Industry has issued a regulation to manage "Wind Power and Power Grid Operation" (temporary). It spells out the principle and pricing of wind power when it is connected to a power grid. Specifically, the price difference between wind power and average power cost is to be shared by the entire grid. However, it is not yet implemented. This requires the cooperation of the Huabei (north China) grid because Inner Mongolia is supplying power to Beijing. Moreover, the amount of power delivered to Beijing is increasing year after year. It accounts for more than 1/3 of the electricity generated in Inner Mongolia. The State Pricing Bureau and other authorities should set policies to encourage accordingly.

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5.2 Reducing tariff is important for importing advanced equipment.

In view of our long term energy needs and the ever more stringent environmental protection requirements, every country in the world is focusing on developing and utilizing renewable energy sources and is encouraging and supporting wind power. A number of developing nations are taking measures to reduce or eliminate import duties for advanced equipment. China has yet to set a policy in this area. Wind power equipment is costly to build. With a 40 percent tariff, it will make it even harder for the industry to grow. In the early stage of large scale development of wind power, before such equipment can be manufactured domestically, there is an urgent need for the government to reduce the import tariff on advanced wind power equipment as an incentive to encourage this industry to grow. In addition, under a nationwide plan, the government should support two to three manufacturers to develop a domestic wind machine manufacturing industry. After we are able to manufacture such equipment domestically by way of importing, digesting and absorbing foreign technology and innovation on our own, this tax advantage can be eliminated.

5.3 Securing funding is the key.

Since wind power fits our national environmental protection policy and national renewable energy development policy, the government should provide financial support in the form of low interest loan or subsidy. The pace of development can be accelerated only with sufficient funding. In order to create additional conduit to obtain capital, we should allow our foreign partners to take their profits out in hard currency. Since wind power cannot generate any hard currency, the only way for a foreign investor to recover its investment to go through a normal foreign exchange process. Inner Mongolia has the ability to manage wind power as a business to build large scale wind power plants, grasp modern technology and management model, and train construction and management personnel to turn Inner Mongolia into a world class wind power farm. It will contribute to our national goal of having 1,000,000 kW of installed capacity.

Research and Development of Dawanshan Wave Power Station

963A0024A Chongqing XIN NENGYUAN [NEW ENERGY SOURCES] in Chinese Nov 95 Vol 17 No 11, pp 23-28

[Article by Gao Xiangfan [7559 4382 1581], Yu Zhi [0151 1807], Liang Xianguang [2733 6343 0342], Jiang Niandong [5592 1819 2639], You Yage [3266 0068 2047] and Wang Wei [3769 0251] of Guangzhou Institute of Energy Conversion, the Chinese Academy of Sciences: "Research and Development of Dawanshan Wave Power Station"]

[FBIS Translated Text] **Abstract.** The Dawanshan Island experimental power plant in the Pearl River estuary is China's first on-shore wave power plant which converts wave energy by using an oscillating wave column (OWC). Status of OWC wave power plant development in other countries and progress made in the development of the 3 kW Dawanshan wave power device are discussed. The design of a 20 kW on-shore wave power plant and issues associated with its air chamber are also presented.

1. Introduction

Building an on-shore wave power plant at Dawanshan Island was first proposed in 1984. Modeling was done in 1985 and construction began in 1986. By the end of 1987, rocks were blown away by explosives and concrete was poured for the air chamber and the plant structure. Actual experiments on the air chamber began in 1989. In February 1990, electricity was successfully generated by the 3 kW wave power device. However, the test was temporarily halted because the device could not handle large waves over a long period of time. In 1991, a decision was made to build a 20 kW on-shore experimental wave power plant at the same site.

The Dawanshan wave power plant uses an OWC to convert wave power into electricity. Despite the fact that there are a number of wave energy conversion mechanisms, OWC is still considered to be the most promising system. It is a pneumatic wave energy device with an air chamber connected to the ocean. The water column in the air chamber oscillates as a result of wave agitation. The water column compresses the air at the top of the chamber and creates an oscillating air flow to drive a turbine to generate electricity. The system is simple in structure. It converts the low speed wave energy to a high speed air flow. It is cheap to build and is very reliable. Since it uses air as the medium, the generator turbine does not come in contact with seawater which eliminates problems associated with corrosion. This improves the survivability of the device. Nevertheless, we still encountered a number of unique problems during the construction of the Dawanshan wave power plant which are different from those associated with a conventional power plant or other oceanic engineering projects.

This paper will briefly describe the development of on-shore OWC power plant around the world and will present the results obtained from the 3 kW device at

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Dawanshan. The design of the 20 kW wave power plant and issues associated with the modification of the air chamber will be discussed in detail. The 20 kW wave power plant will be equipped with a symmetric wing air turbine and a variable speed, constant frequency generator. It will operate in parallel to a diesel generator and will serve as an auxiliary power plant for the troops stationed on the island. This is China's first experimental wave power plant. During the course, we gathered a great deal of experience and obtained a large amount of data in actual operation. It is the foundation for future large wave power plants in China.

2. Status of OWC Wave Power Plant Development Abroad

2.1 40 kW on-shore fixed wave power plant in Japan[1]

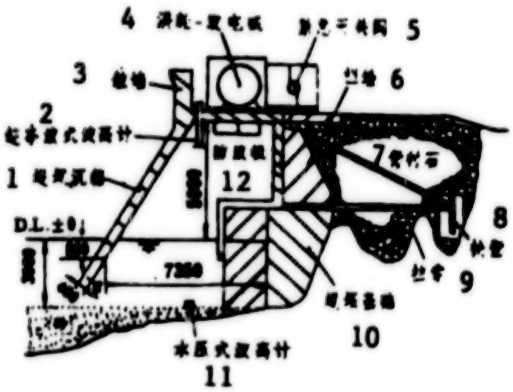

Fig. 1. Japan's 40 kW Wave Power Plant

Key: 1—caisson, 2—wave height gauge, 3—sea wall, 4—turbine generator, 5—emergency switch, 6—retention wall, 7—supporting rock, 8—supporting wall, 9—cable, 10—dam foundation, 11—hydraulic wave height gauge, 12—protective plate

Figure 1 is a diagram of the 40 kW on-shore wave power plant built in 1983 in northwestern Japan. It is the first on-shore experimental wave power plant in the world. It is located in a rocky ravine and has a concrete structure. The air chamber is 8.1 m wide, 5 m deep and approximately 5 m^2 in cross section. It is equipped with a horizontal symmetric wing turbine generator with a turbine diameter of 1.34 m. A trial run over an entire winter season demonstrated that the maximum power output is 40 kW when the wave is 4 m tall. The average power output is 11.3 kW. The overall efficiency is 11 percent. After the experiment was completed, due to environmental and management concerns, the generator was removed. The site is open for tourists. It is our understanding that it is still capable of producing power if a generator is installed.

2.2 500 kW Multiple Resonance Wave Power Plant in Norway[2]

Figure 2 shows the diagram of a 500 kW multiple resonance OWC wave power plant built in 1985 on an island off the coast of Bergen, Norway. This is the largest on-shore wave power plant in the world. It operated continuously for almost two years and supplied electricity to the power grid on the island. The power plant was built under a cliff. The lower part of the air chamber is a concrete structure built on a solid rock foundation. The chamber is approximately 7 m wide and deep. The leading part of the air chamber is about 6 m long. There is a large steel pipe, 3.5 mm in diameter, on the top of the chamber. It is 16 m above sea level. A symmetric wing air turbine is located at the top of the pipe. The turbine is 2 m in diameter and its operating speed is 1000 - 1500 rpm. The nominal capacity is 500 kW and the maximum transient power is 1000 kW. In December 1988, a huge Atlantic hurricane with 20 m wave knocked the steel pipe and generator into the ocean. This wave power generator was equipped with a near perfect operating and protective system and is a relatively successful demonstration wave power plant. All ocean engineering related issues are yet to be resolved.

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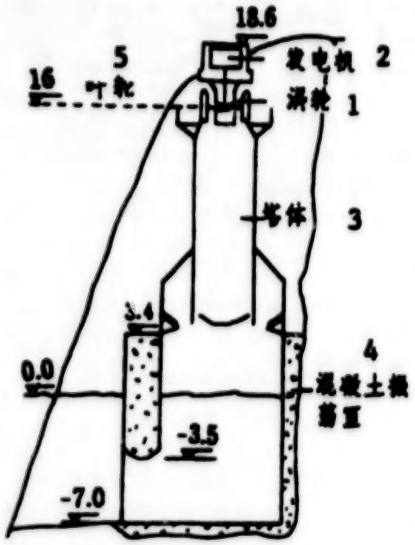

Fig 2. Norway's 500 kW MOWC Wave Power Plant

1—turbine, 2—generator, 3—tower, 4—concrete oscillation chamber, 5—blade

2.3 Wave Power Plant in Sakata, Japan[3]

Figure 3 shows the wave power plant built on the breakwater in Sakata, Japan in 1989. It is a part of the breakwater and has a hollow caisson. Wave is brought into the air chamber from its front opening which is 20 m wide and 24.5 m deep. Originally, the design capacity is 120 kW. At first, it had a 60 kW horizontal symmetric wing air turbine generator. It consists of two 1.3 m diameter turbines in series. The electricity generated is transmitted by underwater cable to a land-based control room. It is used for hot water heating, water warming for fishing farming and light tower power source. It is also being used to conduct experiments and is also a tourist attraction. When the effective wave height is 3.01 m and wave period is 7.9 s, the turbine runs at 1250 - 2100 rpm and the generator output is 20 - 60 kW. This corresponds to an air chamber efficiency of 59 percent, turbine efficiency of 37 percent, generator efficiency of 91 percent, and overall efficiency of 20 percent.

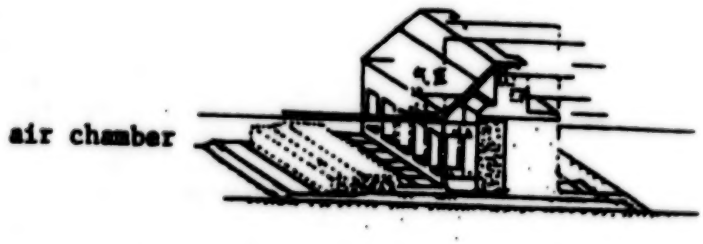

Fig. 3. Wave Power Plant on the Breakwater of Sakata, Japan

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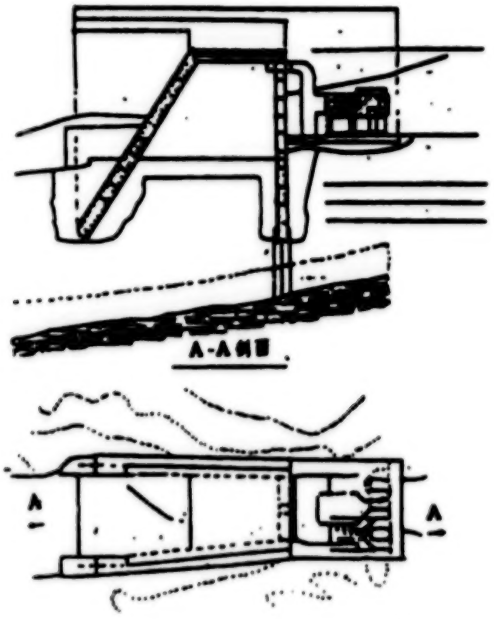
2.4 United Kingdom's 75 kW OWC Wave Power Plant[4]

In 1991, a 75 kW wave power plant was built on the island of Islay in western Scotland in the U.K. (see Figure 4). It is built on a rock ravine on the coast. The air chamber is 4 m wide and 10 m deep. It is equipped with a horizontal symmetric wing air turbine generator and the power generated is fed into the local power grid. The United Kingdom invested a great deal of effort into wave energy device in the 1970's. As a result, 10 promising devices were chosen. The wave power plant at Islay is the first experimental wave power plant built in Britain.



a - A Cross Section

3. Dawanshan Wave Power Plant[5]

3.1 Site and Sea Condition

The Dawanshan Wave Power Plant is built on the southern tip of Dawanshan, an island in the Pearl River estuary. It faces the wide open South China Sea almost without any island or reef breaking the incoming waves. The water is over 20 m deep. According to the data gathered at a wave observation station near the plant in 1984, the average wave height is $H_{1/10}$ = 1.1 m and mean period is T = 5.8 seconds year-round. In winter, the sea is rougher due to strong seasonal wind. The average wave height is 1.25 m and the mean period is 6 seconds. In summer, due to numerous typhoons, the maximum wave height is over 10 m. The mean tidal rise in the area is only 1.9 m. However, the water level may rise by as much as 2 m during a storm. A large tidal rise is not good for a fixed OWC wave energy system.

3.2 Air Chamber Structure and Sea Experiment

The air chamber has an opening on the side with a bell shaped front and is built with concrete on rocks with its back against a cliff. The chamber is 4 m wide, 3 m deep and has a 6 m long front. The bell shaped opening is 6 m wide. It was tested between 1989 - 1991 and found that the air chamber has a relatively high waver energy conversion efficiency. On the average, it is 50 - 150 percent and could reach over 250 percent. This type of air chamber structure has excellent wave concentrating effect[6].

3.3 Generating Power Using the 3 kW Wave Generator[7]

In the early stage, Dawanshan was equipped with a symmetric wing air turbine dc generator. The diameter of the turbine is 0.8 m. The generator is a dc claw generator rated at 3 kW at 1500 rpm and the nominal voltage is 110 V. An experiment conducted in February 1990 showed that under the sea condition provided

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by the Dawanshan Oceanography Station, i.e., average wave height $H_{1/10}$ = 1.3 m and mean period T = 4.8 s, the average maximum power generated is 3.9 kW. The maximum transient power generated is 5.8 kW and the maximum rotation speed is 4000 rpm. The generator system survived a rigorous test at excessive speed and under overload condition. Figures 5 and 6 show the actual data recorded on 22 February 1990.

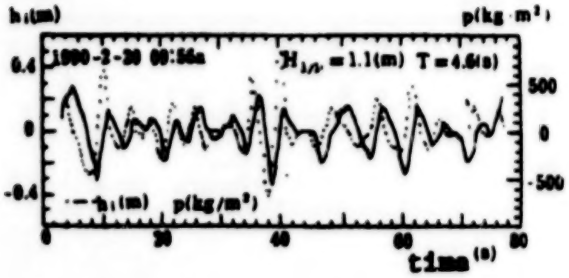

Fig. 5. Water Column and Pressure in the Air Chamber solid line: water column, dotted line: pressure

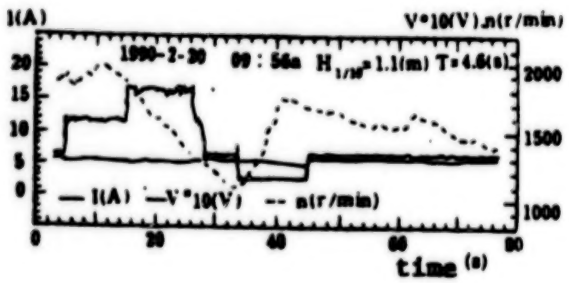

Fig. 6. Generator Rotation Speed, Current Output and Voltage

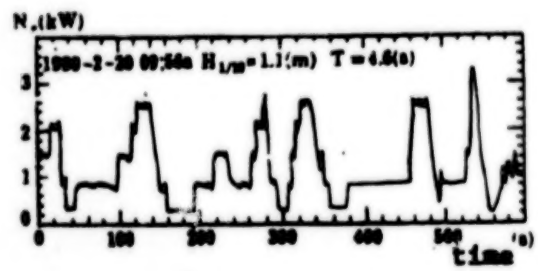

Fig. 7 Generator Output vs. Time

3.4 Discussion on Results of Initial Experiment[8]

Experimentally, it was found that the energy conversion efficiency of the air chamber is relatively high. The 3 kW generator system is considered to be a success. However, it failed to operate continuously because of a lack of a protective system, its small capacity and its low installation height. It could not operate normally in large waves. In 1991, following a recommendation given by experts, it was agreed that a 20 kW OWC wave power plant is to be built on the same site.

4. Development and Construction of a 20 kW On-Shore Wave Power Plant

4.1 Power Plant

The Dawanshan experimental wave power plant is built on rocks. It employs an OWC pneumatic wave energy converter, the most advanced and mature technology available in the world. It has a steel reinforced concrete air chamber. The generator system consists of a symmetric air turbine and a variable speed, constant frequency ac generator. During the development process, in addition to encountering problems associated with wave power plant and conventional power plant, there were special ocean engineering related hurdles which made the project very demanding and difficult.

4.2 Modification of the Power Plant Structure

Theoretical calculation and wave making pool experiment results showed that a 3 m high incident wave could produce a 7 m high water column at the top of the air chamber. The height of the water column might reach 50 m during a typhoon. The original concrete building was destroyed by the water column. To this end, the structure of this 20 kW power plant was modified in the following three areas (see Figure 8).

4.2.1 Transitional Air Chamber and Wave Cone[9]

A transitional air chamber was built on top of the air chamber to prevent the water column from crashing into the generator during a storm. In addition, two wave cones were designed and installed on top of the air chamber over the 1 m and 0.8 m diameter holes. Construction of the transitional air chamber was completed in June 1993 and it has survived several typhoon attacks.

4.2.2 Increasing Height of Generator

The generator is installed approximately 12 m higher than before by building a steel reinforced concrete pipe on top of the transitional air chamber. At this height, wave cannot reach this level. This ensures the normal

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operation of the generator even in bad weather and makes it easier to manage.

4.2.3 Emergency Safety Door[9]

The air pipe as cast in August 1993. It was destroyed by typhoon 16 which came on land at the mouth of the Pearl River on September 17. We experience 10 m waves and 50 m tide along the coastal cliffs. It was a rare occurrence. When repairing the air pipe at the end of 1994, in addition to strengthening the concrete pipe (to 3 atm), an emergency safety door was added between the bottom of the pipe and the transitional air chamber. When the pressure in the air chamber exceeds 2.5 atm, the emergency safety door will open automatically to relieve the pressure in order to protect the generator unit.

4.3 Estimation of Generator Capacity[10]

4.3.1 OWC Air Chamber Wave Energy Conversion Efficiency

$\eta_s = N_s/(BN_w)$

where η_s is the wave energy conversion efficiency of the air chamber, N_s is the power of the air flow, N_w is the power of the incident wave and B is the lateral width of the air chamber.

Based on actual data collected between September 1989 and April 1991, when the incident wave height is $H_{1/10}$ = 1 m, wave period T = 3.4 s, air chamber nozzle ratio R = 1/150, the wave height inside the air chamber is H_i = 0.42 m, mean absolute pressure P = 154 mmH_2O and mean air flow power at the output of the nozzle N_s = 3.7 kW. Assuming B = 4 m and N_w = 4.1 kW, then η_s = 0.9.

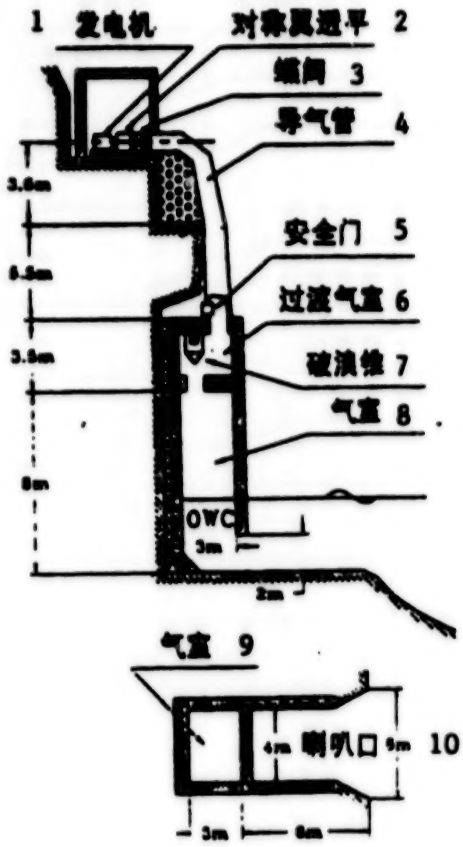

Fig. 8. Schematic Diagram of the 20 kW Experimental On-Shore OWC Power Plant at Dawanshan

1—generator, 2—symmetric wing turbine, 3—butterfly valve, 4—air pipe, 5—emergency safety door, 6—transitional air chamber, 7—wave breaker cone, 8—air chamber, 9—air chamber, 10—bell-shaped opening

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4.3.2 Generator Capacity

$N_w = 0.3\ H^2_{1/10}TB$ (kW)

$N_e = 0.3\ \eta H^2_{1/10}TB$ (kW)

where N_e is the output of the generator, and

$\eta = \eta_T \eta_e \eta_s = 0.45 \times 0.85 \times 0.9 = 0.34$

is the overall energy conversion efficiency of the air chamber, turbine and generator system. $\eta_T = 0.45$ is the efficiency of the air turbine, $\eta_e = 0.85$ is the efficiency of the generator and $\eta_s = 0.9$ is the efficiency of the air chamber.

On the basis of the wave data collected a the Dawanshan Oceanography Station, a center of wave energy is plotted using a statistical method. Corresponding to this center, the wave height is H = 1.5 m and period is T = 6.5 s. Under this sea condition, the power output of the OWC power plant can be calculated as follows[5]:

$N_{ep} = 0.3 \times 0.34 \times 1.95^2 \times 6.5 \times 4 = 6.4$ (kW)

According to the pattern of wave height distribution, the average maximum wave height $H_{1/100} = 1.3\ H = 1.3 \times 1.5 = 1.95$ (m). Assuming an average period of 7 s, the average peak power output of the power plant is

$N_{e\,max} = 0.3 \times 0.34 \times 2.5^2 \times 7 \times 4 = 18$ (kW)

Therefore, the capacity of the turbine generator is rated at 20 kW in order to ensure normal operation even on a stormy day (not including typhoon). Furthermore, this gives us some reserve to keep up with peak power. In the event of a typhoon, the power plant will cease its operation before the typhoon hits.

5. Technical Specifications

Air Chamber: lateral opening width 4 m, front lead-in 6 m, bell-shaped opening width 6 m, air chamber depth 3 m, cross section 12 m^2, air chamber height (including underwater portion) 8 m, transitional air chamber height 3 m, air pipe length approximately 10 m.

Air Turbine: symmetric wing (Wells) turbine, outer diameter 1 ,.

Variable Speed Constant Frequency AC Generator: rated power 20 kW, nominal voltage 380 V, rated rotation speed 1780 rpm, operating speed range 900 at 2200 rpm.

The OWC power plant is operating in parallel with a diesel generator. All test runs have been completed in 1995.

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Strategy To Develop Wind Power Analyzed

963A0024B Beijing SHUILI FADIAN [WATER POWER] in Chinese 12 Nov 95 No 11, pp 1-3

[Article by Wang Shucheng [3076 1859 6134], vice minister of the Ministry of Electric Power Industry: "Strategy to Develop Wind Power in China," MS received 10 August 1995. Note: This is a speech given by Wang Shucheng on 10 January 1995 at a national workshop on wind power development. In view of the slow start of alternate energy development in China, in order to accelerate its pace, the manuscript of the speech is edited and published here.]

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1. Status of Wind Energy Development Around the World

Renewable energy sources include solar, wind, geothermal, ocean (wave and tidal), biomass, etc. In recent years, wind energy is being developed at a fast pace. For instance, it has reached 1.5 - 1.6 million kW in the U.S., approximately 1/2 of the total in the world. There is 450,000 kW of wind power in Denmark, 150,000 kW in the Netherlands and 80,000 kW in India. At the present time, wind energy represents a small fraction in the electric power grid. However, it represents 3 percent of the power grid in Denmark. Nevertheless, from the planning standpoint, by the year 2000, it will account for 10 percent of the total power generated in California and 5 percent in Denmark. In addition, the United Kingdom, Germany, Spain, France, Japan, Canada and India have plans to step up wind energy development. Ukraine has signed a contract with a U. S. firm to build a 50,000 kW wind power plant. This id primarily driven by the two following factors.

One is to meet environmental protection concerns. Since the international meeting on the environment in Rio de Janeiro, Brazil, environmental protection has become a top priority issue. Even with clean coal burning technology to generate electric power thermally, it still consumes oxygen and produces carbon dioxide. In addition, it requires costly procedures to remove sulfur and nitrogen. The use of fossil fuel also creates the greenhouse effect. Nuclear power seems to be a good way to produce electricity. In the next century, China is definitely going to use nuclear power. However, many countries are forbidden from developing nuclear power by law. In developed capitalist countries, hydroelectric power is no longer being pursued because it is already being well tapped. From the environmental standpoint, issues such as population relocation and fish protection have stopped construction of large hydropower projects. We should also pay attention to a theory developed abroad. After a hydropower project is built, land is submerged under water which reduces photosynthesis. As a result, the amount of oxygen released is decreased and the level of carbon dioxide in the atmosphere increases. Nevertheless, hydropower is still a good approach in China at the present time. Compared to all those methods discussed above, wind power is undoubtedly the cleanest and almost pollution free renewable energy source. However, wind power also has two problems. One is noise, but it is not a major issue. The other is birds, especially when windmills are on the flight paths of migrating birds. However, this is not an issue for existing wind power plants in China. In conclusion, wind power is a clean energy that deserves some attention.

The second reason is that wind power generator is becoming more competitive compared to other sources of energy after going through a development phase. Unit capacity is getting larger and technology is more advanced. It is not competitive when the unit capacity is 100 kW or 200 kW. When it reaches 450 kW to 500 kW, it becomes competitive. In the U.S., the cost per kW for a windmill farm is $1,000. The cost to produce electricity for a power grid is 5 cents per kWh. In Denmark and Holland, the per kW cost is also in the $1,000 - $1,200 range and the cost to produce a kWh for the grid is 5.5 cents. Currently, the worldwide capacity to manufacture 500 kW wind machine is approximately 500 - 600 units per year and it is already in production. The cost to construct a hydropower project is also $1,000 per kW. It costs $1,500 per kW at Yitaipu. In China, a large scale hydropower project cost 7,000 - 8,000 yuan per kW, which is close to $1,000. The cost goes up to 12,000 - 15,000 yuan per kW for a medium size hydropower plant. If all existing economic policies, loan policies, appreciation taxes and income taxes remain unchanged, on the basis of a report issued by the Water Regulation Committee and the Beijing Institute after surveying 8 power plants, our cost of electricity is 0.85 - 1.02 yuan per kWh, i.e., over 10 cents. The cost of electricity to the power grid at Dayawan is 7 cents per kWh and the construction cost per kW is even higher. The construction cost for a thermal power plant in China exceeds 4,000 yuan per kW, excluding expenses associated with sulfur and nitrogen removal. If such processes are included, then the per kW cost will be 6,000 - 7,000 yuan. In conclusion, the cost of wind power falls dramatically as the unit capacity of the wind machine increases. Moreover, it is still dropping. It is competitive compared to other energy sources. Environmental protection forces us to search for new energy sources. Wind power stands out because it has an acceptable construction cost and can produce electricity at a reason price.

2. Understanding and Promoting Wind Energy

The key to developing wind power is to resolve three issues regarding perception. One is that wind power cannot be developed to scale. The second one is that electricity generated by wind power is inherently high cost. The third one is that wind power is unstable.

In terms of scale, many people believe that a number of small windmills cannot produce much electric power. However, this is not the case. In California, along a strip of land 15 km long and 5 km wide, there are 2,400 windmills with a combined capacity of 240,000 kW. The Tianhe wind farm is a 70,000 kW facility located on the top of a mountain. From a distance, it

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looks like butterflies in the sky. Most of wind machines are 300 kW units. An ordinary wind farm in Denmark consists of a dozen windmills. They are built on the sea, on dikes and on land. Many farms and factories have their own windmills. The electricity generated is consumed on the spot. Any extra capacity is supplied to the power grid to maintain stability. It is usually accompanied by an auxiliary diesel generator. This kind of setup is very common all over Denmark. When 1,000, 2,000 and 3,000 kW wind generators are installed in the Dabangcheng wind farm in Xinjiang, the scale will be huge. 50,000, 100,000 and 200,000 kW facilities are potentially possible in Xinjiang, Inner Mongolia and on islands along the coast. The total potential wind power capacity in China is 250 million kW and that of hydropower is 370 million kW. This illustrates how big the potential of wind power is.

As for cost, construction cost per kW is not a factor to be considered abroad. The only cost is the cost of a kWh of electricity. Whether a power plant is profitable depends upon the cost of electricity. If we totally rely on imports, then it will cost us $1,000 per kW to install windmills. As we gradually move production in China, the cost will drop. To develop 1 million kW of wind power will require an investment of 1 billion dollars. The World Bank will give us a loan of the order of 500 - 600 million dollars to build a hydropower plant. Even completely using foreign capital, developing 1 million kW of wind power is equivalent to building two hydropower plants.

With regard to the stability of the power source, the concept is that there is electricity as long as there is wind. Wind power is in its infancy in China. Even at 1 million kW, it is still a small fraction in the power grid. Therefore, it will not create any fluctuation and instability. When its proportion increases in the future, this issue needs to be addressed. For instance, when the wind suddenly stops and the load drops, a 100,000 kW system has minimal impact on a large grid. However, it will have an adverse effect on a small grid. Nevertheless, as long as the grids are connected, the effect is manageable. Furthermore, there are a number of ways to compensate for this instability problem. For example, most systems have a diesel backup to stabilize the power source. In the U.S., people are working on compressing air to store energy. When there is no demand from the power grid, wind energy can be stored in the form of compressed air. A hole is dug in the ground to produce and store compressed air. It can be released later to generate electricity. A famous expert with the World Weather Organization suggested that Inner Mongolia has the potential of delivering 1 million kW of electric power to Beijing by combining wind power and compressed air energy storage. Some hydroelectric power experts also suggested combining wind power with water pumping energy storage.

In addition, another issue concerns hours of usage per year. In the U.S. and in Europe, it is around 2,500 hours. In some wind farms in China, the number exceeds 3,000 hours. In Xinjiang, it is 3,400 hours and in Nanhau it is 3,000 hours. The average annual usage hours is 3,300 hours for a large to medium size hydroelectric power plant and 2,700 hours for a small size plant. These indicators show that wind power can be developed into a large scale operation.

3. China's Wind Power Development Strategy

First, China's wind power is developing into an industry. Changes are needed in organization structure, engineering procedure, rules and regulations, and various legal issues. We should move from a small scale experimental effort toward a well planned industry. To develop wind power, we must have a series of rigorous plans. When a few wind machines are involved, it does not make much difference if wind resource survey is inadequate or geological consideration is incomplete. However, when it involves a 50,000 kW or 100,000 kW wind power plant, the impact of geological concerns is substantial. It is especially important for us to be well prepared as we march toward large scale development of wind power. Very rigid requirements must be met in feasibility studies for a wind farm. We must be well planned. Don't just buy a windmill and start to generate electricity wherever it is windy. We must move from an experimental stage toward commercialization. Infrastructures such as organization and review procedure must be established.

Next, wind power must be in close alliance with the electric power industry. The electric power bureau must be involved first hand. Of course, other organizations should not be excluded. Without the electric power system, it will be very difficult to accomplish this effort. The issues include connecting to the power grid, distribution, cost of electricity, capital investment and loan guarantee. We recommend that heads of electric power bureaus from those provinces of interest should go visit several sites to learn about wind power. Hopefully, they will become enthusiastic supporters. Of course, we hope wind power can be successfully developed in Xinjiang, Inner Mongolia and Nanhau. It will be much easier once there is a model we can follow.

Third, to develop wind power we must begin with building wind power plants. Building wind power plants will stimulate the entire wind power industry to grow. For instance, should we first try to manufacture windmills domestically or build wind power plants? Based on our

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experience in hydroelectric power, building power plant ought to happen first. It will stimulate the manufacture, development, design and teaching of wind machines. In other words, let the market be the driving force.

Fourth, we should begin developing wind power primarily in the form of joint venture with foreign countries. 500 kW wind machines are already in production abroad. 750 kW and 1,000 kW units are currently under development. We should directly import 300, 400, and 450 and 500 kW units to build wind power plants with foreign investment. We should also attract foreign capital to build windmill manufacturing plants in China. It will accelerate the pace of our development. Gradually, we will be able to make it domestically. When a capacity of 400,000 to 500,000 kW is reached, we will have sufficient understanding of the technology. Chinese people are smart, especially in mathematics and control systems. It does not seem too difficult to make the blades. The primarily reason to start with foreign investment is to acquire the formula for the bonding agent.

In conclusion, China must develop its wind power industry as soon as possible. First, we must recognize wind power as an industry. Next, we have to push the electric power bureau to the front line so that the electric power industry becomes the primary driving force behind wind power. Third, the entire industry will be stimulated by the construction of wind power plants. Fourth, we should take advantage of foreign investment to build up wind power at the beginning and then gradually develop the capability to produce windmills domestically.

Construction and Management of Dabancheng Wind Power Plant in Xinjiang

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[Article by Wang Wenqi [3769 2429 0796] of the Wind Power Plant of Xinjiang Electric Power Bureau: "Construction and Management of Dabancheng Wind Power Plant in Xinjiang," MS received 10 Aug 95]

[FBIS Translated Text] **Abstract.** Xinjiang Wind Power Plant is an organization engaged in electric power generation, manufacturing and research and development. It has an installed capacity of 10,700 kW which ranks number one in China. In 1995, the gross product value generated per person reached 1.3 million yuan. Dabancheng Wind Power Plant has operated continuously for 1000 days since it was first put into production. It has generated 35,810,000 kW h of electricity and has contributed significantly to level the load of the Urumqi power grid. The plant has produced encouraging results in money raising, safe production, manufacturing of wind machines and plant management. It has created a clear path for the development of wind power, a clean energy source, in China.

Key Words: wind power, Dabancheng wind power plant, construction, management, safe production, domestic manufacturing.

With strong support from various levels of government, wind power in Xinjiang is taking the lead in China after 3 and 1/2 year of hard work by the Wind Power Plant of Xinjiang Electric Power Bureau. It is now the focus in China. We have received a great deal of support in terms of funding and technology from all over the world. We are accelerating the pace of development to turn Xinjiang into a wind power base in the world, as directed by the Ministry of Power Industry.

1. The Wind Power Plant

The Wind Power Plant was founded in late 1991. It was followed by the formation of Xinjiang Institute of Wind Power Design by the Ministry of Power Industry and Xinjiang Zhongdan Wind Energy Corporation, a joint venture with a foreign firm. In realty, these three entities are one organization. It is comprised of two plants and two departments; i.e., a wind power plant, a wind machine manufacturing plant, a design laboratory and a general office. The organization currently employs 20 people. All technical people are college trained professionals capable of performing tasks such as power plant planning, feasibility study and engineering design. Furthermore, they can also install, operate and maintain wind power plants. The manufacturing facility can assemble wind machines to meet international standards. It has completed twenty-three 300 kW units and all of them have passed quality control tests.

The Xinjiang Wind Power Plant has an installed capacity of 10,700 kW and a fixed asset of 110 million yuan. It occupies 7,000 m^2 of building space and its wind machines are spread over 1.4 km^2 of land. The primary step-up transformer station has a capacity of 2 x 20,000 kVA. It has four 110 kV circuits, two 35 kV circuits and twenty 10 kV circuits. The local load is supplied directly by 10 kV circuits. The output has reached a capacity of that of a 50,000 kW wind machine. Construction at Dabancheng has reached a considerable scale as a wind power base. It has the essential conditions to support work, production and people.

On the basis of the pricing policy formulated by the Ministry of Power Industry and the new electricity rate determined by the Price Bureau of the Xinjiang Autonomous Region, and the number of employees at the plant, the product value generated per employee is

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480,000 yuan in 1993, 620,000 yuan in 1994, and 1.3 million yuan in 1995. It is expected to exceed 2 million yuan in 1996. We are confident that we can stay close to the cutting edge in wind power to equip and manage wind farms with modern equipment and technology. Moreover, we also intend to be innovative in a short period of time.

2. Safe Production

The Dabancheng plant was put into production in late 1992. It has been operating safely and continuously for 1,000 days and has produced 35.81 million kW h of electricity. With regard to daily management, in view of the fact that there is a large number of wind machines scattered over a wide area and most of them are working high up in the air in a hostile environment, we particularly stress on safety. Rules and regulations concerning safety are rigorously followed when we operate, maintain and repair our equipment.

The number of effective utilization hours at Dabancheng is 3,200 - 3,400 hours. It is generating electricity 84 percent of the time year-round. The daily load curve shows that peak load is at 16:00 - 20:00. The plant is actually play a role in peak shaving. Developing a large scale wind power plant with pumped-storage power plants is the best way to deal with load leveling in Urumqi. By doing so, the economic benefit of the power grid can be drastically improved. Not only coal consumption can be reduced, but also the environment is better protected.

Maintenance schedules are being rigorously followed by the maintenance crew at Dabancheng. All components and control systems are checked and lubricated, if necessary, twice a year to prevent major incidents and to ensure safe operation.

3. Fund Raising

According to the plan prepared by the Ministry of Power Industry and the Xinjiang Autonomous Region, the installed capacity at Dabancheng is 30,000 kW in 1995, 100,000 kW in 2000, 400,000 kW in 2010 and 1,000,000 kW in 2020.

Dabancheng has a annual reserve of 25 billion kW h of wind energy. It has a potential installed capacity of 4 million kW and can produce 7.5 billion kW h of electricity. It is the top priority area for wind power development.

The first issue is capital. In addition to internally raised money, it is being primarily supported by various organizations through the following four conduits.

3.1 State Planning Commission

This portion of the funding is for infrastructure construction. It consists of two parts; i.e., foreign capital and domestic capital.

Foreign capital: a total of $42.6 million was approved (including $11.6 million of gift, $10 million of interest free loan, and $21 million of export credit loan) to purchase 56,400 kW of wind machines. $7.6 million of foreign capital has been invested in manufacturing of wind machines. $10 million of loan is being processed. Another $25 million is being reviewed.

Domestic capital: before reaching an installed capacity of 10,000 kW, Dabancheng wind power plant is not included in the national plan. Now, the State Development Bank has agreed to include it in the plan at a total cost of 140 million yuan. It is under review.

3.2 State Economic and Trade Commission

This portion of the funding is for technology improvement. It received a 4,500,000 yuan loan for technology improvement. It is being spent on a demonstration project to manufacture wind machines domestically. This has been upgraded to an industry level "double plus" project. The total installed capacity will reach 50,000 kW and the total investment is 400 million yuan.

3.3. State Environmental Protection Bureau

The State Environmental Protection Bureau is funding a 50,000 kW wind power plant through the global environmental protection foundation. The purpose is to reduce the release of gases causing the so-called greenhouse effect. In order to encourage clean energy, the amount of money for wind power will exceed that for thermal power. The State Environmental Protection Bureau has submitted a $10 million proposal for approval.

3.4 State Science and Technology Commission

On 20 July 1995, the national wind power conference was held in Wulumuqi. A site visit to Dabancheng was also organized. The State Science and Technology Commission has agreed to allow us to participate in the Ninth 5-Year Plan and is willing to fund a portion of the project.

These funds have already been included in various plans. The total amount exceeds 800 million yuan. We ought to have enough money to install 100,000 kW of capacity by the year 2000. We are actively pursuing bank loans at this point.

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4. Construction of Wind Power Plant

4.1 Selection of Plant Site

First, we have to ask the weather bureau to provide wind data at the plant site. We must have wind speed and wind direction data at a height of 10 m at any potential site. The best indicators are 10 minute or 1 hour average wind speed and wind direction. We should have at least two years worth of data as basis for further investigation.

4.2 Construction of Experimental Station

Since a wind power plant is almost always a new experience anywhere, it is prudent to begin at a small scale in order to verify the wind resource and to train the operating and maintenance crew. In 1987, a 100 kW unit was put into operation in Xinjiang. After two years of operation, we acquired some experience and trained a number of people. It serves as a foundation for future construction. Dabancheng is a success story. However, Alashankou is a failure. It has sufficient wind. However, it does not have an adequate power grid to build a wind farm.

4.3 Building Wind Power Plant Infrastructure

A wind power plant is a costly construction project. It is necessary to establish a series of procedures to deal with research and design. The Institute of Wind Power Design was founded to address this issue. In order to design a good wind power plant, various software packages were imported to analyze wind resources to obtain an optimal layout.

4.4 Using Foreign Capital

Currently, wind machines are not manufactured in China. It takes hard currency to get started which is difficult for a small business. Wind power is an environmental protection project. It is extremely appropriate to take advantage of small foreign government guaranteed loans to conduct our experiment. This experience will then help us develop large scale wind power plants in the future. However, large scale development must be done on a national basis. It is no longer practical to rely on foreign government guaranteed loans because the purpose of such an arrangement is to support projects that are socially beneficial but economically unfavorable. It is primarily given to capture market share. Hence, we have to be independent when we are ready for large scale development. The existing 10,000 kW capacity creates a path for wind power to be included in the national plan.

4.5 Concerning Bids

A fair and equitable bidding system is used to spend foreign loans. Most distributors of foreign companies in China are fair and straight. However, there are exceptions. Some distributors will try to interfere with the process if they fail to win the contract. It is extremely important to select a reliable supplier with a reputable distributor.

4.6 Signing and Executing Contracts

It is a very delicate issue concerning a wide range of fields, including technology, business and law. Initially, due to lack of experience, we agreed to all the terms requested by the foreign supplier. Later, we realized we must take an proactive role. By doing so, we saved a great deal of money. For instance, they quoted a transportation cost to Xingang. We found a company that would deliver the equipment to the wind farm at the same cost. In addition, a contract should have provisions to deal with all potential contingencies, such as installation, technology transfer and foreign exchange rate fluctuation. Contract negotiation should be taken seriously.

5. Domestic Production of Wind Machines

After building a wind power plant, it is clear to us that developing wind power depends upon lowering the cost of wind machine. It is economically beneficial once it reach a certain scale. To this end, technology transfer is an attached condition to every piece of equipment purchased from abroad. To accelerate this process, we formed a joint venture — Xinjiang Zhongdan Wind Energy Inc. By way of assembling twenty three 300 kW wind machines, a team of technicians were trained.

Presently, we are making some progress toward manufacturing 300 kW units in China. Except for the blade, most major components can be produced domestically. The steel structure, frame and housing made locally have been certified by the foreign manufacturer. The generator was successfully developed by Xiantan Electric Motor Company. The transmission is being built at Xian Aircraft Corporation. The gear box will be ready by the end of the year. The automatic control is being developed at Nanjing Institute of Automation and a prototype is scheduled to be released in September. By the end of 1995, 70 percent of the 300 kW unit can be manufactured domestically. The blade is being produced at Shanghai Institute of Fiberglass. It is scheduled to be ready for production in the first half of 1996. We plan to begin to produce a small number of 300 kW wind machines in 1996 after testing and modification.

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Wind machine technology is being developed at a fast pace around the world. 500 - 600 kW units are in production and are commercially available. On a cost per kW basis, compared to a 300 kW unit, a 600 kW unit lowers the cost by 25 percent, which is substantial. In order to keep up with advanced wind power technology and to drastically lower cost, in addition to importing equipment, we should continue to bring in advanced technology to improve the level of development effort in China. Xinjiang has some advantage in this area. A foreign manufacturer has agreed to transfer blade production technology. We plan to develop a 600 kW unit in conjunction with various component manufacturers in the Ninth 5-Year Plan and begin commercial production to ensure that Xinjiang has 100,000 kW of installed capacity by 2000.

6. Management

Of course, it is not easy to build a wind power plant. However, it also takes a great deal to manage one. A wind power plant has a number of unique characteristics. To manage such a plant we need to address the following.

6.1 Team-Building

(1) Usually, a wind power plant is far away from the city. Its working environment is undesirable. In the winter, it is cold, however, the air density is high and is the best season to generate electric power. It is usually at -20°C with 7 - 8 level gale force wind. When a unit breaks down, one must climb up to a 30 m high housing to fix it. This is routine in a wind farm. Technicians must be extremely hard working and career driven to stay in such an environment.

(2) The individual unit capacity is small. However, a wind power plant has numerous wind machines. It is high tech and fully automated. Different professionals must be an expert in his or her field to handle an emergency, not only in theory but also in hands-on experience. The areas of expertise consist of electric power, automatic control, computer and mechanical structure. They are expected to be able to perform various tasks such as planning, design, construction, installation, operation, maintenance and testing, as well as assembly of wind machines and manufacturing different components. In other words, they are required to participate in the entire process at the plant. This will improve the level of the technical staff. It is particularly good for a small company. This is a basic training method for our technical staff.

(3) The technical staff must work at the plant and find a research topic from the production line. In principle, every person should have his or her subject. In realty, there are numerous problems to be resolved at the line. It is a place for college graduates, graduate students and PhDs to use their talents. However, we do not offer a comfortable working environment. The work condition is also hazardous. Therefore, we have to take care of their needs. Our principle is that we are very demanding in performance on the job. However, employee benefits are well above normal. Thus, the stability of the team is secured. It also ensures continuous development of wind power in the future.

6.2 Establishing Stringent Rules and Regulations

A wind machine is a very dangerous piece of equipment operating in a hostile environment. A major incident will destroy the machine and cause loss of life. It has happened before around the world. Therefore, stringent rules and regulations must be put in place to ensure safe production.

We formulated a series of rules and regulation after reviewing similar rules and regulations concerning operation, maintenance and design for the electric power industry and taking unique characteristics associated with wind power into consideration. It consists of 40 parts. This guarantees that management of a power plant will be gradually improved during the construction phase. It is a first step toward normalization in construction. These rules and regulations will be further modified as production takes place.

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